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USATECOM PROJECT NO. 4-4-0180-01

FINAL REPORT OF ENGINEERING FLIGHT TEST OF THE CH-37B

MARCH 1965

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126

UNCLASSIFIED
Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author)
U.S. ARMY TEST & EVALUATION COMMAND
U.S. ARMY AVIATION TEST ACTIVITY
EDWARDS AFB, CALIFORNIA

2a. REPORT SECURITY CLASSIFICATION
UNCLASSIFIED

2b. GROUP

3. REPORT TITLE
FINAL REPORT OF ENGINEERING FLIGHT TEST OF THE CH-37B

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)
FINAL REPORT, 5 SEPTEMBER 1962 THROUGH 27 MAY 1963

5. AUTHOR(S) (First name, middle initial, last name)
ROBERT N. TURK, Project Engineer
JOSEPH C. WATTS, CWO, U.S. Army, TC, Project Pilot

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
MARCH 1965	129	11

8a. CONTRACT OR GRANT NO.

b. PROJECT NO.
USATECOM PROJECT NO. 4-4-0180-01

c.

d.

9a. ORIGINATOR'S REPORT NUMBER(S)
USAATA PROJECT NO. 62-28

9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)
NA

10. DISTRIBUTION STATEMENT
[redacted]

11. SUPPLEMENTARY NOTES

12. SPONSORING MILITARY ACTIVITY
US ARMY AVIATION SYSTEMS COMMAND
ATTN: AMSAV-R-F, PO BOX 209
ST. LOUIS, MISSOURI, 63166

13. ABSTRACT

Engineering flight tests were conducted on the CH-37B to determine the effects of the changes from the CH-37A configuration on the performance and stability and control characteristics.

This evaluation was conducted by the U.S. Army Aviation Test Activity (USAATA) at Edwards Air Force Base, California, and auxiliary sea level test sites near Bakersfield California. The program consisted of 29 hours of flight testing, and was conducted during the period 5 September 1962 through 27 May 1963. Interim reports of test results were submitted and preparation of the final report was delayed by project priorities.

The test aircraft (U.S. Army S/N 54-0998) had been modified from a CH-37A to a CH-37B by the incorporation of the following major changes:

a. Installation of Automatic Stabilization Equipment (ASE);
b. Relocation of the horizontal stabilizer to a position opposite the tail rotor;
c. Installation of larger-capacity oil tanks;
d. Replacement of the split cargo door with a sliding cargo door.

The performance data obtained during this test were compared with those presented in report "Limited Evaluation of the H-37A Equipped with Wide Chord Blades" (AFFTC-TR-59-14). A comparison of the level flight performance data revealed that no significant differences existed that would make necessary revisions of the Operator's Handbook (TM-55-1520-203-10). ( )

(continued on reverse side)

DD FORM 1 NOV 65 1473 REPLACES DD FORM 1473, 1 JAN 64, WHICH IS OBSOLETE FOR ARMY USE.

UNCLASSIFIED
Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Engineering flight tests CH-37B transport helicopter Performance Stability and Control						

Item 13 continued

The stability and control data were compared with those presented in the report "H-37A, Limited Stability and Control Evaluation" (AFFTC-TR-60-15). Not considering the ASE modification, the major stability and control difference was experienced about the pitch axis. A larger degree of damping was present in the CH-37B and the short-period oscillations of the aircraft were approximately one-half those of the CH-37A. This change was attributed to the relocation of the horizontal stabilizer.

Laterally and directionally there was no appreciable difference between the CH-37B and the CH-37A. Directional control response in a hover remained excessive in the CH-37B.

The ASE increased the damping and provided better dynamic stability characteristics in the CH-37B. This was accomplished without a reduction in control sensitivity. The increased stability and the high control sensitivity improved the overall controllability and reduced the pilot effort.

U. S. ARMY AVIATION TEST ACTIVITY

DDC AVAILABILITY NOTICE

[redacted]

FINAL REPORT OF ENGINEERING FLIGHT TEST OF THE CH-37B

USATECOM PROJECT NO. 4-4-0180-01

USAATA PROJECT NO. 62-28

ROBERT N. TURK
Project Engineer

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Abstract

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Laterally and directionally there was no appreciable difference between the CH-37B and the CH-37A. Directional control response in a hover remained excessive in the CH-37B.

The ASE increased the damping and provided better dynamic stability characteristics in the CH-37B. This was accomplished without a reduction in control sensitivity. The increased stability and the high control sensitivity improved the overall controllability and reduced the pilot effort.

SECTION 1 General

1.1 REFERENCES

a. Message TCMMD-AB-5-28-2, Headquarters, Department of the Army (DA), to U. S. Army Aviation Materiel Command (USAAVCOM), 8 May 1962, subject: Authorization to Reinstate 20-Flying Hour Program to Evaluate Stability and Control and Performance Changes Resulting from Changes Incorporated During the CH-37 Remanufacturing Program.

b. Message TCMAC-EH-37-050-01249, USAAVCOM, to U. S. Army Aviation Test Activity (USAATA), 11 May 1962, subject: Authorization to Conduct a 20-Flying Hour Program on the CH-37B, S/N 54-0998, to Evaluate Stability and Control and Performance Changes Resulting from Changes Incorporated During the CH-37 Remanufacturing Program.

c. AFFTC-TR-59-14, "Limited Evaluation of the H-37A Equipped with Wide Chord Blades," U. S. Air Force Flight Test Center (AFFTC), May 1959, DDC Document No. AD-214005.

d. Technical Manual TM-55-1520-203-10, "Operator's Manual, Operator's and Crew Members' Instructions; Army Model CH-37A and CH-37B Helicopters," Department of the Army, August 1963.

e. Military Specification MIL-M-7700A, "Manuals; Flight," 14 February 1958.

f. AFFTC-TR-60-15, "Limited Stability and Control Evaluation, H-37A," AFFTC, June 1960.

g. Military Specifications MIL-H-8501 and MIL-H-8501A, General Specifications for "Helicopter Flying and Ground Handling Qualities," 5 November 1952.

h. AFFTC-TN-58-27, "The Effect of Gear Extension on Level Flight Performance of the H-37A," AFFTC, October 1958, DDC Document No. AD-203728.

i. AF TR No. 6273, "Flight Test Engineering Manual," AFFTC, Revised January 1953.

j. SER-56161, "Flying Qualities of the H-37B Helicopter with a High Pylon Stabilizer, (S1509-2000)," Sikorsky Aircraft Company, undated.

k. SER-56194, "Performance of H-37B with Lear ASE Installation," Sikorsky Aircraft Company, 27 June 1961.

1.2 AUTHORITY

a. Message TCMMD-AB-5-28-2, Headquarters, DA, to U.S. Army Aviation Materiel Command, (USAAVCOM), 8 May 1962, subject: Authorization to reinstate 20-Flying Hour Program to Evaluate Stability and Control and Performance Changes Resulting from Changes Incorporated During the CH-37 Remanufacturing Program.

b. Message TCMAC-EH-37-050-01249, USAAVCOM, to U. S. Army Aviation Test Activity (USAATA), 11 May 1962, subject: Authorization to Conduct a 20-Flying Hour Program on the CH-37B, S/N 54-0998, to Evaluate Stability and Control and Performance Changes Resulting from Changes Incorporated During the CH-37 Remanufacturing Program.

1.3 OBJECTIVES

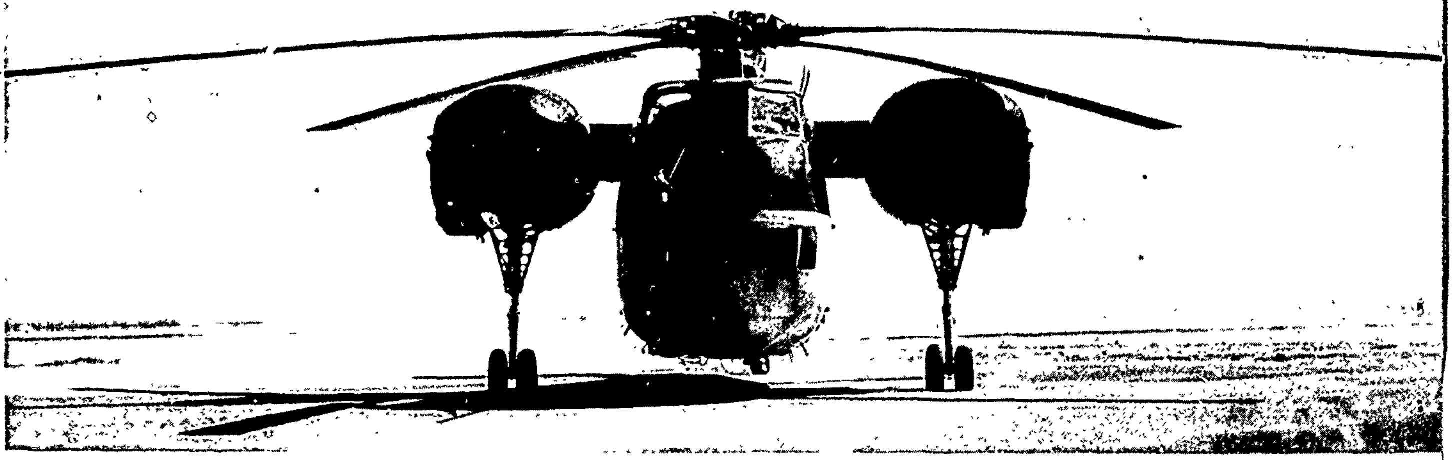
The objective of this test program was to evaluate the performance and stability and control differences resulting from changes incorporated during the CH-37B remanufacturing program.

1.4 RESPONSIBILITIES

USAATA was authorized to execute this test program by DA through USAAVCOM.

1.5 DESCRIPTION OF MATERIEL

The CH-37B is a twin-engine, single-lifting-rotor, all-metal transport helicopter.



The CH-37B results from a modification of the CH-37A. The following items outline the major changes incorporated in this program:

a. Automatic Stabilization Equipment (ASE)

This equipment was installed to improve the handling qualities characteristics of the helicopter.

b. Fixed Stabilizer

The adjustable stabilizer located on the sides of the fuselage was replaced with a fixed stabilizer located on the right side of the tail-rotor pylon.

See Appendix II for complete description of test aircraft.

1.6 BACKGROUND

The CH-37A, S/N 54-0998, arrived at Edwards Air Force Base, California, on 30 January 1957. It was returned to the manufacturer for modification on 17 October 1960. Major changes included the addition of Lear Automatic Stabilization Equipment (ASE) and repositioning of the horizontal stabilizer.

On 14 July 1961 the aircraft was returned for testing to Edwards Air Force Base as a CH-37B. The U. S. Air Force Flight Test Center (AFFTC), Edwards Air Force Base, California, was requested to conduct an evaluation of changes, due to modification of the aircraft, on the performance and stability and control characteristics of the "B" model. The aircraft, however, was reassigned for testing to USAATA (then the Transportation Materiel Command Aviation Test Office (TMCATO)) after five hours of flight tests were conducted by the AFFTC.

Flight testing by USAATA began on 5 September 1962 at Edwards Air Force Base, California. Testing was conducted at Bakersfield and Edwards Air Force Base, California.

Interim reports of test results were submitted and preparation of the final report was delayed by project priorities.

1.7 FINDINGS

1.7.1 PERFORMANCE

The results of the speed-power tests indicate that the CH-37B required slightly more power at high airspeeds and slightly less power at low airspeeds than the CH-37A (Reference 1.1.c). This small difference cannot be attributed solely to changes in design configuration because of other factors that may have influenced the change in level flight performance.

Some other factors that contributed to the measured differences include different airspeed systems, wear on the reciprocating engines and the resulting power determination problems.

The total change in performance was less than 5 percent; therefore, changes in the Operators' Manual (Reference 1.1.d) are not required. (Reference 1.1.e, MIL-M-7700A, Paragraph 3.1.2.12.2: changes will be necessary if alternate configurations result in a performance variation of more than 5 percent.)

1.7.2 STABILITY AND CONTROL

1.7.2.1 Static Longitudinal Stability

At airspeeds above 45 knots calibrated airspeed (KCAS), the static longitudinal trim stability was positive (stable) for all flight conditions tested. The speed stability became more positive as airspeed was increased. In general the CH-37B required an average of 7 percent more forward longitudinal cyclic control than the CH-37A (Reference 1.1.c); this probably resulted from the new location of the horizontal stabilizer. Qualitatively, there was no difference in static longitudinal stability between the CH-37A (Reference 1.1.c) and the CH-37B. Static longitudinal stability in the CH-37B was the same with the automatic stabization equipment (ASE) "on" and "off."

1.7.2.2 Static Lateral-Directional Stability

The static lateral-directional stability characteristics of the CH-37B were generally acceptable and positive dihedral was present for all conditions tested. Test data indicated that an at least 10 percent control position margin existed for stabilized sideslip angles of 45 degrees at low speeds and for sideslip angles of 15 degrees at high speeds. During level flight dihedral effect increased with airspeed. In autorotation the effective dihedral was generally less than that for level flight; however, it remained slightly positive. Although the data did not reveal any significant difference between static lateral-directional stability with the ASE "on" and that with the ASE "off" qualitative pilot comments indicated improved stability with the ASE operative.

1.7.2.3 Forward and Rearward Flight

Control positions in forward and rearward flight were found to be slightly different than in the H-37A aircraft probably due to the relocation of the horizontal stabilizer.

Sufficient control was available to fly up to 30 knots in rearward flight and there were no unusual lateral or directional control requirements.

1.7.2.4 Dynamic Stability

The dynamic stability characteristics were satisfactory with the ASE "on"; however, when the ASE was turned "off" damping decreased with increasing airspeed. At cruise airspeeds the short-period pitching motion was divergent with the ASE "off." Pulse inputs at low airspeeds and in hovering flight resulted in an oscillatory divergent motion that required pilot recovery during the second half of the cycle. Oscillation periods in general were one-half those recorded for the CH-37A in AFFTC-TR-60-15 (Reference 1.1.f). This increased damping in forward flight was attributed to the relocated horizontal stabilizer.

In all flight regimes a right-pedal input resulted in a turn to the right with an oscillation about the yaw axis and left-pedal pulses created an oscillation about the trim axis with no heading change. With the ASE "off" there was no appreciable difference in dynamic directional stability between the CH-37A and CH-37B. Yaw rates from the oscillation were high but the relatively long time required to reach the maximum allowed the pilot to recover without difficulty. The high tail-rotor location and change in tail-rotor thrust resulted in an initial small adverse lateral-directional coupling.

1.7.2.5 Controllability

The controllability of the CH-37B was adequate. No appreciable difference was found between the controllability with the ASE "on" or "off." Test results indicated that lateral-directional sensitivity was nonlinear at higher airspeeds. This is not objectionable since the large control inputs required to reach the nonlinear condition are seldom necessary during normal operations. In hover and at low speeds a maximum angular velocity of 8.5 degrees per second resulted from a 1-inch longitudinal cyclic input. Time required to obtain the maximum angular velocity averaged 2.8 seconds in hover and 2.9 seconds at low airspeeds. The controllability requirements for MIL-H-8501A (Reference 1.1.g), Paragraph 3.2.11.1, were met by the CH-37B.

1.7.2.6 ASE Malfunctions

The helicopter reaction to a simulated ASE malfunction was similar to that resulting from a 10 percent to a 20 percent pedal pulse input. To evaluate properly the resulting motions of the CH-37B to ASE failures (hard-overs), therefore, it was necessary to analyze both the results from the simulator panel and the results from the pilot-induced step-type control inputs. The initial motion was in the same direction as the control movement that resulted from the failure. With the controls fixed the reaction was usually a long-period lightly damped oscillation. It was necessary for the pilot to initiate immediate recovery following a forward cyclic failure at high speed. In this case the motion was a divergent pitch-down and recovery was initiated 2.5 seconds after the failure. Following a pilot-induced hard-over, which was a 1-inch step input with the ASE inoperative, immediate corrective action was required to prevent excessive rates and extreme attitudes from developing.

1.7.2.7 Flight Control System

Longitudinal and lateral breakout forces were satisfactory and there was no apparent dead-band region. The incorporation of the ASE servo system in the CH-37B reduced these forces to a comfortable level and with all systems operating represented a marked improvement over these forces in the CH-37A (References 1.1.c and 1.1.f). With the stick trim turned "off" and all servos operating, less than 1 pound of force was required to move the cyclic control stick through full travel. The high directional control friction forces were unsatisfactory. They were greater than those reported for the CH-37A in AFFTC-TR-60-15 (Reference 1.1.f). These high pedal forces, in addition to the high directional sensitivity, increased the tendency for the pilot to over-control and made precision hovering difficult.

1.8

1.8.1 PERFORMANCE

Analysis of the test results did not indicate sufficient justification for changing the performance data presented in the Operator's Manual (Reference 1.1.d). Significant variations in level-flight maximum airspeed, fuel-flow characteristics, power required, and power available, however, were found during this evaluation. These variations were not considered to be the results of changes in the horizontal stabilizer location or the side-door conversion. The variations were instead attributed to the differences in the engine characteristics of the CH-37A and CH-37B and the power-measuring techniques employed in the different tests.

1.8.2 STABILITY AND CONTROL

1.8.2.1 Static Longitudinal Speed Stability

The static longitudinal speed stability of the CH-37B was satisfactory and was found to be slightly more positive than that reported for the CH-37A. This increase in positive stability was attributed to the pitching moment from the relocated horizontal stabilizer. Static longitudinal speed stability was not affected by operation of the ASE.

1.8.2.2 Static Lateral-Directional Stability

For all flight conditions other than low airspeed autorotation the static lateral-directional stability was satisfactory and dihedral effect was positive. The helicopter had good pedal-fixed maneuvering capability in level flight. During low-speed autorotation a "wallowing" motion was prevalent and directional control inputs had little effect on yaw attitude.

1.8.2.3 Forward and Rearward Flight

Forward and rearward flight tests indicated that more than 30 percent of the aft longitudinal stick travel remained at airspeeds up to 30 knots true airspeed (KTAS) in rearward flight.

1.8.2.4 Dynamic Stability

With the exception of longitudinal motion no significant changes in the dynamic stability were apparent between the CH-37A and CH-37B with the ASE "off." With the ASE "on," however, dynamic stability was improved considerably in all cases. Relocation of the horizontal stabilizer apparently provided greater longitudinal damping in forward flight.

1.8.2.5 Controllability

Control sensitivity was essentially the same for the CH-37B as for the CH-37A and was not significantly affected by operation of the ASE.

Control response about the longitudinal and lateral axes was satisfactory with the ASE "off" and was comparable to the CH-37A test results. The directional control response was excessive and combined with the high pedal friction forces caused frequent over-controlling in hovering flight. For all control axes operation with the ASE "on" lowered the control response and provided better flying qualities, particularly during precision hovering.

1.8.2.6 ASE Malfunctions

ASE failures that resulted in maximum-authority control inputs were controllable if recoveries were initiated within a reasonable time. Excessive delay resulted in extreme aircraft attitudes. The helicopter responded to an ASE feedback circuit failure (oscillating full-authority control inputs) by oscillating about the failure axis. The best pilot technique for recovery was to fix the control and immediately turn off the ASE.

1.9

a. No changes should be made in the Operator's Manual based on the performance data in this report. (Paragraph 1.7.1)

b. Automatic Stabilization Equipment should be installed in all CH-37 aircraft to improve the handling qualities. (Paragraphs 1.7.2.2, 1.7.2.4 and 1.7.2.7)

c. A study should be conducted to verify the structural integrity of the tail-rotor pylon. Rapid yaw movements resulting from large pedal inputs or directional hard-overs may be of sufficient magnitude to allow the forces to exceed the structural limits of the aircraft. (Paragraph 1.7.2.4)

d. A note briefly describing the helicopter's response to ASE failures in the various modes and the best method of recovering from each should be added to the Operator's Manual (TM55-1520-203-10). (Paragraph 1.7.2.6)

DETAILS and RESULTS of SUB-TESTS

2.0 INTRODUCTION

Performance and stability and control tests were conducted by USAATA at Edwards Air Force Base, California, to determine any changes resulting from the modification of the basic CH-37A helicopter to the CH-37B configuration.

The performance phase of the test was limited to level-flight speed power tests due to the relatively short time allotted for this project. During these tests, data were obtained to determine fuel flow and power required of the CH-37B for comparison purposes.

The stability and control tests were conducted in the following sequence: static stability tests; dynamic stability tests; and controllability tests. This sequence allowed the test program to be conducted in the safest and most logical manner.

Performance tests were conducted in a stabilized condition in non-turbulent air. All stability and control tests were conducted in non-turbulent atmospheric conditions so that test data would not be influenced by uncontrolled disturbances.

The test program, consisting of 29 flight hours, extended from 5 September 1962 to 27 May 1963 and was conducted at Edwards Air Force Base and Bakersfield, California.

The test aircraft was fully instrumented for stability and control and performance flight tests.

2.1 PERFORMANCE

2.1.1 LEVEL FLIGHT

2.1.1.1 Objective

Tests were conducted in level flight to determine speed, power required, and fuel flow. Data from these tests were used for comparison of the level flight performance of the CH-37A and CH-37B.

2.1.1.2 Method

Speed-power tests were conducted at various conditions of altitude and gross weight while the rotor speed was held at a constant rpm. Each speed power was flown at a constant value of gross weight divided by density (W/σ). This technique required an increase in altitude as fuel was consumed.

Tests were conducted at density altitudes from 5035 feet to 10,130 feet. Gross weights ranged from 24,290 to 30,820 pounds. Engine and rotor speeds were maintained at 2600 and 185.5 rpm respectively.

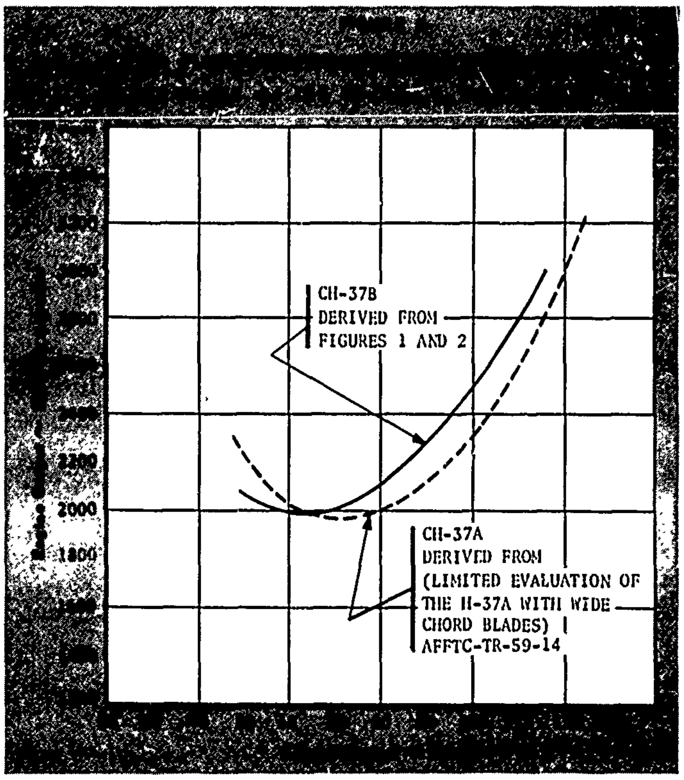
2.1.1.3 Results

The results of the level flight performance tests are presented graphically in Figures No. 3 through 6, Section 3, Appendix I. Non-dimensional summary plots are presented in Figures No. 1 and 2, Section 3, Appendix I. The CH-37B fuel-consumption-versus-shaft-horsepower curves are presented in Figure No. 77, Section 3, Appendix I.

2.1.1.4 Analysis

A comparison of the CH-37B test results with the findings in the report AFFTC-TR-59-14, "Limited Evaluation of the H-37A Equipped with Wide Chord Blades" (Reference 1.1.c), indicates a small difference in level flight performance. The shapes of the CH-37A speed-power curves are similar to those of the CH-37B. The slight variance in characteristics, however, is illustrated in Figure A.

FIGURE A



The CH-37B required greater power at high airspeeds and less power at low airspeeds than the CH-37A. The displacement of the curve may be attributed to any or all of the following:

a. Airspeed Calibration. The airspeed calibrations used during the two test programs differed. The CH-37A airspeed data were obtained from the standard ship's system whereas the CH-37B was evaluated with airspeeds obtained from a test (boom) system. The different position errors from the calibrations resulted in calibrated airspeeds that were generally 1 to 2 knots higher in the CH-37A.

b. Fuel Flow. The CH-37B evaluation was conducted with relatively high-time engines (approximately 150 and 350 hours). An analysis of the fuel flow data shows that for the same horsepower output these engines required a much greater fuel flow than the engines used in the CH-37A test aircraft.

c. Method of Measuring Power. The engine power data for this report were obtained from the engine manufacturer's performance curves (power chart). The engine power for the CH-37A was determined from torquemeter data.

The test results indicate that the actual performance difference between the two configurations is less than 5 percent. Thus, no changes in the Operator's Manual are necessary (Reference 1.1.e, MIL-M-7700A, Paragraph 3.1.2.12.2: changes will be necessary if alternate configurations result in a performance variation of more than 5 percent.)

2.1.2 AIRSPEED CALIBRATION

2.1.2.1 Objective

The objective of this test was to determine the airspeed position error for the test airspeed system.

2.1.2.2 Method

The ground speed course method was used to determine the airspeed calibration of the test system. The aircraft was flown on reciprocal headings over a measured course at various stabilized airspeeds. The tests were conducted at the following conditions: the average gross weight was 26,000 pounds and the center of gravity (C.G.) was located at Station 236.5 (Mid); no external stores were installed and the landing gear was down.

2.1.2.3 Results

The results of the airspeed calibration are presented graphically in Figure No. 76, Section 3, Appendix I.

2.1.2.4 Analysis

The position error on the test airspeed system was nonlinear. At airspeeds below 20 knots, the system was not reliable.

2.2 STABILITY AND CONTROL

2.2.1 STATIC LONGITUDINAL SPEED STABILITY

2.2.1.1 Objective

The objective of these tests was to determine the static longitudinal speed stability and flying qualities as the airspeed was varied from trim during climb, level flight, and autorotation.

2.2.1.2 Method

The tests were conducted at the flight conditions listed in Table 1.

[illegible]					
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]					

Control positions and aircraft attitudes were recorded for each trim airspeed. The helicopter was stabilized at each airspeed by varying the controls as required for the flight conditions.

2.2.1.3 Results

Test results are presented graphically in Figures No. 7 and 8, Section 3, Appendix I.

It should be noted that the data for the report AFFTC-TR-60-15, "H-37A Limited Stability and Control Evaluation"

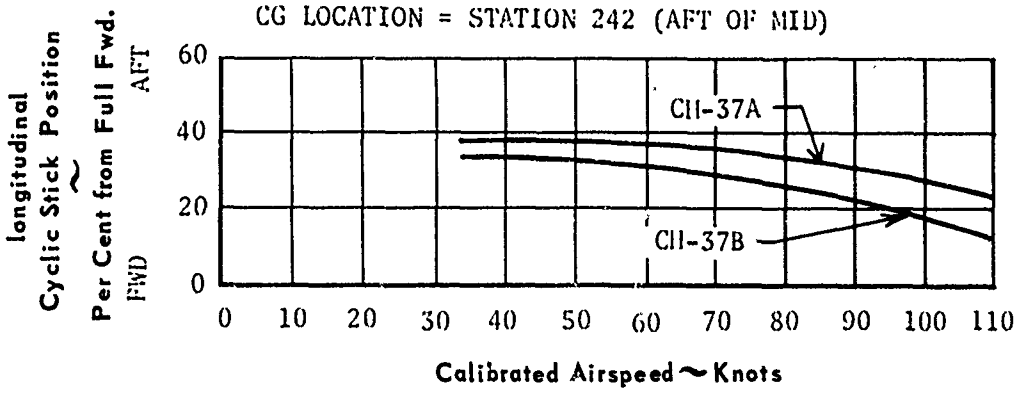
(Reference 1.1.f), were obtained from tests of the CH-37A, S/N 54-0998, while that helicopter was fitted with wide chord blades but still rigged for narrow chord blades. In essence, this means that the comparative CH-37A control position curves presented on the static stability plots in this report may vary somewhat from curves that would have resulted had the blades been rigged in the wide chord configuration position as they were in the CH-37B test aircraft. The plots of static longitudinal speed stability, static directional stability, and control positions in forward and rearward flight are affected. Performance data and dynamic stability plots are not influenced by this rigging difference. The blade variations are as follows:

[redacted]

The different rigging configurations are presented in Figure B for comparative purposes.

FIGURE B
LONGITUDINAL CONTROL POSITION VS. CALIBRATED AIRSPEED
CH-37B, S/N 54-0998

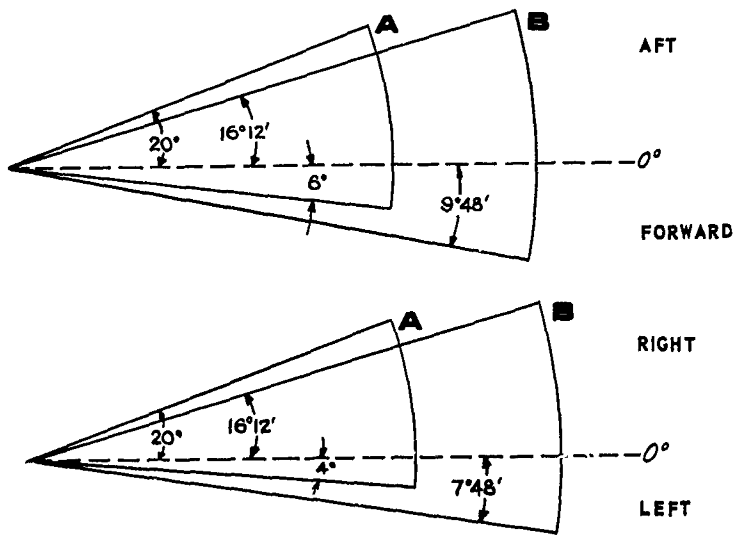
ROTOR RPM = 186
AVERAGE GROSS WEIGHT = 31,500 LB
CG LOCATION = STATION 242 (AFT OF MID)



2.2.1.4 Analysis

Static longitudinal speed stability was determined to be positive for all airspeeds above 45 knots at all flight conditions. There were no objectionable discontinuities and the speed stability became more positive as airspeed was increased. Qualitative pilot comments indicated that the static speed stability characteristics were the same with the ASE both "on" and "off." A comparison of the CH-37B longitudinal control positions as a function of calibrated airspeed is presented in Figure C.

FIGURE C



A-BLADE PITCH VARIATION OF THE CH-37A
B-BLADE PITCH VARIATION OF THE CH-37A

The CH-37B required an average of 7 percent more forward longitudinal cyclic control and the speed stability gradient became more positive as the airspeed was increased. The forward control position and more positive stability were attributed to the greater nose-up moment created by the new stabilizer location. Qualitatively, there was no detectable difference between the static longitudinal speed stability characteristics of the CH-37A and the CH-37B.

2.2.2 STATIC LATERAL-DIRECTIONAL STABILITY

2.2.2.1 Objective

The objective of the static lateral-directional stability tests was to determine static lateral-directional stability and effective dihedral.

2.2.2.2 Method

Static lateral-directional stability was investigated through analysis of recordings of the longitudinal, lateral-directional control positions and the resulting bank angles required to stabilize at various sideslip angles. Static directional stability was determined from the relationship between pedal position and angle of sideslip. Effective dihedral was determined from the relationship between lateral control and sideslip angle.

The tests were conducted for the conditions listed in Table 3.

TABLE 3. STATIC LATERAL-DIRECTIONAL [illegible]

Flight Condition	[illegible]	[illegible]	[illegible]
Level Flight	[illegible]	[illegible]	[illegible]
Autorotation	181	42, 53 and 57	[illegible]

The tests were flown at an average density altitude of 5360 feet and at an average gross weight of 30,770 pounds.

2.2.2.3 Results

Test results are presented graphically in Figures No. 9 through 14, Section 3, Appendix I, and are compared with CH-37A test results (Reference AFFTC-TR-60-15 "H-37A Limited Stability and Control Evaluation").

2.2.2.4 Analysis

The CH-37B exhibited positive static directional stability in level flight. The test results indicated increasing positive stability gradients as airspeed was increased. ASE operation did not have a significant influence on the static directional stability. Extrapolation of the test data indicated that an at least 10 percent control position margin existed for stabilized sideslip angles of 45 degrees at low speeds and 15 degrees at high speeds.

The static directional stability in autorotation was determined to be weakly positive for airspeeds of 42 to 57 knots with only 0.16 inches of pedal input required to change the sideslip angle from 15 degrees left to 15 degrees right. Maintaining a stabilized sideslip angle in autorotation was extremely difficult. A "wallowing" motion was experienced and directional control inputs had little effect on yaw attitude. These test results were similar to those reported during the CH-37A tests. As in the level flight tests no significant difference was noted between the ASE "on" and "off" data; however, qualitative pilot comments indicated that stability was improved and the directional flying qualities were better with the ASE operative. Sufficient directional control was available to produce sideslip angles similar to those obtained in level flight.

Dihedral effect, as indicated by lateral control positions during steady sideslip, was positive at all speeds in level flight and in autorotation above 50 knots. During level flight dihedral effect increased with airspeed and was the same with the ASE both "on" and "off." This positive dihedral effect, coupled with the strong static directional stability, gave the helicopter good pedal-fixed maneuvering capability in level flight. During autorotation the dihedral effect was weakly positive for airspeeds above 50 knots. This weak or neutral dihedral effect, in addition to the marginal static directional stability, made it extremely difficult to maneuver or maintain yaw attitudes during autorotational descents. Turbulence increased the pilot effort during autorotation and could have prevented a safe autorotational landing.

2.2.3 FORWARD AND REARWARD FLIGHT

2.2.3.1 Objective

The objective of the low-speed forward and rearward flight tests was to determine the control required to hover in winds.

2.2.3.2 Method

Head-wind and tail-wind hovering conditions were simulated by flying the helicopter forward and rearward in calm air. A calibrated pacer ground vehicle was used to record speed as the helicopter was stabilized at the various test conditions. The resulting control positions and attitudes were recorded for each stabilized trim airspeed.

2.2.3.3 Results

Test results are presented graphically in Figure No. 15, Section 3, Appendix I.

2.2.3.4 Analysis

Notable differences were found between the CH-37A and CH-37B collective and pedal positions. These were mainly attributed to the CH-37A tests' being conducted at a rotor rpm of 186 as compared with 193 for the CH-37B. Some variation was also attributed to the change in the location of the horizontal stabilizer. More than 30 percent of the aft longitudinal stick travel remained at 30 knots in rearward flight. There were no unusual lateral or directional control requirements as rearward flight speed increased up to 30 KTAS.

2.2.4 DYNAMIC STABILITY

2.2.4.1 Objective

The objective of the dynamic stability tests was to determine the dynamic stability characteristics of the CH-37B. Tests were conducted to evaluate the change in dynamic stability of the CH-37A as a result of the change in configuration.

2.2.4.2 Method

The CH-37B dynamic stability characteristics were determined from analysis of the time histories of the helicopter motions resulting from pulse-type control inputs. In this analysis, damping, control lag and qualitative pilot comments were considered.

Tests were conducted in hover and level flight about the longitudinal, lateral and directional axes with the ASE both "on" and "off." Hovering dynamic stability tests were conducted in calm air at an average density altitude of 1500 feet, a mid C.G. location (Station 236.5), a rotor rpm of 194 and an average gross weight of 30,000 pounds.

Level flight tests were conducted at a 6000-foot average density altitude, an aft C.G. location (Station 242), an average rotor speed of 186 rpm, and an average gross weight of 30,000 pounds. Tests were conducted at both low and cruise airspeeds.[1]

2.2.4.3 Results

Time histories are presented in Figures No. 16 through 33, Section 3, Appendix I.

2.2.4.4 Analysis

2.2.4.4.1 Dynamic Longitudinal Stability

The initial aircraft motion following a longitudinal pulse control input was in the proper direction. With the ASE

[1] Hereafter in this report low airspeed denotes approximately 45 KCAS and cruise airspeed denotes approximately 85 KCAS.

"off" damping decreased as the airspeed increased and at cruise airspeeds the short-period pitching motion was divergent. Pulse inputs at low airspeeds and in hovering flight resulted in an oscillatory divergent motion that required pilot recovery during the second half of the cycle.

The longitudinal motions with the ASE "off" in both low and cruise speed flight had oscillation periods that were approximately one-half those recorded for the CH-37A in the report AFFTC-TR-60-15 (Reference 1.1.f). The relocation of the horizontal stabilizer apparently provided greater damping in pitch during forward flight.

Dynamic longitudinal stability was improved considerably by the addition of the ASE. All pitching oscillations were damped in less than one cycle. Damping was higher at low airspeeds than in hovering flight and some reactions exhibited deadbeat characteristics.

2.2.4.4.2 Dynamic Lateral Stability

In all cases initial helicopter motion following a lateral pulse input was in the direction of the control input. Damping was greatest in hovering flight and at low airspeeds. With the ASE inoperative pilot recovery was necessary because of divergent lateral oscillations. Pitching motions and lateral-directional coupling were present in all flight regimes and in a hover the yaw motion was divergent.

2.2.4.4.3 Dynamic Directional Stability

The helicopter yawed in the same direction as the pulse control input.

With the ASE "off" little difference in dynamic directional stability was noted between the CH-37A and the CH-37B. In all flight regimes a right-pedal input resulted in a turn to the right and oscillation about the yaw axis and left-pedal pulses created an oscillation about the trim axis with no heading change. Yaw rates from the oscillations were high but the relatively long time required to reach maximum rate allowed the pilot to recover without difficulty. The high tail-rotor location resulted in an initial small adverse lateral-directional coupling caused by changes in the tail-rotor thrust. This coupling was prevalent at both low and high airspeeds. An initial nose-up pitch motion followed a left-pedal pulse during hovering flight. In all other conditions, the helicopter pitched nose down after the directional input.

With the ASE "on" all oscillations damped to zero within one cycle. Attitude returned to trim and there was a small opposite roll contributed by the tail-rotor moment about the roll axis. Characteristics were similar for all conditions tested.

2.2.5 CONTROLLABILITY

2.2.5.1 Objective

The objective of the controllability tests was to determine the maximum accelerations and rates that result per inch of rapid step-control input. These tests were conducted to investigate any controllability changes contributed by the change in design of the CH-37A helicopter.

2.2.5.2 Method

Step-control inputs were used to evaluate these characteristics. The analysis of the data included consideration of control lag, maximum values, time-to-reach-maximum values and the resulting helicopter attitudes.

Hovering flight tests were conducted in ground effect (IGE) at 500 to 1000-foot density altitudes with average gross weights varying from 30,150 to 31,025 pounds. The C.G. was at Station 236.5 (Mid) and rotor speed was 186 rpm. Characteristics in forward flight were evaluated at speeds of 45 and 85 KCAS.

2.2.5.3 Results

Test results are presented graphically in Figures No. 40 through 59, Section 3, Appendix I.

2.2.5.4 Analysis

2.2.5.4.1 Control Sensitivity

The control sensitivity was determined through analysis of the angular accelerations resulting from step-type control inputs. No significant differences were found in the comparison of ASE "on" and ASE "off" data. The maximum values obtained and characteristic shapes of the acceleration curves were approximately the same.

Maximum angular accelerations versus control displacements are presented in Figures No. 34, 35, and 36, Section 3, Appendix I. These plots indicate that sensitivity was nonlinear at higher airspeeds about the roll and yaw axes. This nonlinearity is not objectionable since the large control inputs required to reach the nonlinearity condition are seldom required during normal operations.

A comparison of the control sensitivity of the CH-37A and the CH-37B is presented in Table 4.

TABLE 4. COMPARISON OF CONTROL SENSITIVITY OF THE CH-37B & CH-37A
(Sensitivity is measured in degrees per second per inch control deflection)

Flight Conditions:
CH-37A: refer to AFFTC-TR-60-15 (Reference 1.1.f)
CH-37B: refer to Figures No. 34 through 36, Section 3, Appendix I.

	Longitudinal		Lateral		Directional	
	Forward	Aft	Left	Right	Left	Right
Hovering (OGE)						
CH-37B	8.0	8.0	16.3	16.3	25.0	[illegible]
CH-37A	5.5	6.8	29.5	29.5	22.5	[illegible]
Low Airspeed 45 KCAS						
CH-37B	8.0	8.0	14.3	14.3	26.0	[illegible]
CH-37A	5.5	6.8	22.0	22.0	22.5	[illegible]
Cruise Airspeed [illegible] KCAS						
CH-37B	9.8	9.8	13.0	19.0	32.5	[illegible]
CH-37A	8.0	9.0	28.0	28.0	27.0	[illegible]

2.2.5.4.2 Control Response

2.2.5.4.2.1 Longitudinal response (Reference Figure No. 37, Section 3, Appendix I)

Without the ASE the maximum longitudinal angular velocities recorded in hover and at low airspeed were 8.5 degrees per second per inch of longitudinal cyclic input in either direction. The time required to achieve the maximum values of angular velocity averaged 2.8 seconds in a hover and 2.9 seconds at low airspeeds. Time histories of attitude indicated a pure divergence in both directions. The requirements of MIL-H-8501A, paragraph 3.2.11.1, however, are met. During low-speed flight the trim airspeed had changed only 1 to 3 knots at the time of recovery. At cruise airspeeds the pitch angular velocity increased to a value of 11.5 degrees per second for 1-inch control input in either direction. This maximum was achieved approximately 2.5 seconds after the initial control deflection. The C.G. normal acceleration changed approximately 0.3g's in 2 seconds. No significant differences in control response existed between the CH-37A and the CH-37B at cruise airspeed.

With the ASE operative during hover and low airspeed flight the control response was 4.5 degrees per second per inch of forward or aft cyclic movement. Maximum rates were reached in approximately 1.3 seconds in a hover and 1.2 seconds at low airspeeds. The helicopter pitched in the direction of the control input and essentially returned to the initial trim attitude within 8 seconds. When trimmed at 45 knots an aft tep caused the calibrated airspeed to decrease steadily to approximately 25 knots. The calibrated airspeed increased from 45 knots to approximately 70 knots in 7 seconds after a forward step and C.G. normal acceleration slowly decreased to 0.8g's. The very slight adverse lateral-directional coupling that resulted from an aft step was not objectionable. At cruise airspeeds the control response was 5.5 degrees per second per inch of control input and the time required to reach this value averaged 1.1 seconds. These values were the same for both forward and aft inputs. The helicopter stabilized in an attitude several degrees from trim and the airspeed change was 15 or 20 knots within 10 seconds. The C.G. normal acceleration varied approximately ±0.3g's depending on the direction of input.

2.2.5.4.2.2 Lateral Response (Reference Figure No. 38, Section 3, Appendix I)

With the ASE "off" a lateral cyclic step input during hover and low-airspeed flight produced a rolling velocity of 12.5 degrees per second per inch of control displacement in approximately 2 seconds. Aircraft motion following a right step input was right roll, right yaw and nose-down pitch. A left cyclic stick input resulted in a left roll, an initial right yaw, and a nose-up pitch. The right yaw changed to left yaw after several seconds and developed into a coordinated left turn. A right lateral step at cruise airspeed resulted in a roll angular velocity of 20 degrees per second whereas the rate response to the left was only 11.5 degrees per second. In general the helicopter rolled and turned in the direction of lateral cyclic control input. The CH-37A exhibited similar characteristics (Reference 1.1.f, AFFTC-TR-60-15).

With the ASE "on" lateral cyclic movements in hovering or during low-airspeed flight resulted in an angular rolling velocity of 6.6 degrees per second to the left and 7.3 degrees per second to the right. Maximum values occurred 1.1 seconds after control input. In hovering flight the maneuvers caused loss of altitude and early recoveries were necessary because of the close proximity to the ground. At low airspeeds some bank attitudes reached 30 degrees before recovery was initiated but the roll rate damped to approximately 5 degrees per second. Response to left and right lateral cyclic inputs at cruise airspeed with the ASE operative resulted in average maximum roll rates of 7.5 and 11.5 degrees per second respectively. These maximum values were attained in approximately 1 second. The large pitch and yaw attitude changes were not present during tests with the ASE "on."

2.2.5.4.2.3 Directional Response (Reference Figure No. 39, Section 3, Appendix I)

With the ASE "off" directional step inputs provided by abrupt pedal movements in a hover resulted in maximum control responses of 41.0 and 62.0 degrees per second per inch of control input for left and right inputs respectively. These maximum values were reached in 3.7 seconds. At low airspeed the maximum rates dropped to 18 degrees per second for inputs in either direction and peaked in 1.8 seconds. These yaw rates were excessive, especially in a hover; however, pilot recovery was not difficult because of the time required to reach the maximum rate. Although rates differed considerably between the two flight conditions, the helicopter attitude changes were similar. A right pedal input made the helicopter yaw right, roll right, and pitch down. Inputs to the left initiated a left yaw, a slight right roll followed by a left roll, and a slight pitch-up. The CH-37A had essentially the same response characteristics (Reference 1.1.f, AFFTC-TR-60-15). At cruise airspeed the maximum control response increased to 17.8 degrees per second and was achieved in 1.4 seconds after the initial input. Pedal inputs in either direction resulted in coordinated oscillating turns. The helicopter pitched slightly nose down after a right pedal step and slightly nose up after a left input. The CH-37A exhibited similar responses (Reference 1.1.f).

With the ASE "on" maximum yaw rates attained during hover were 15.0 degrees per second in either direction and reached the maximum in approximately 0.9 seconds. At low airspeeds the helicopter entered a turn with a small oscillation about the yaw axis. Control responses were 9.0 degrees per second attained in 1.3 seconds after control input. At cruise airspeed the maximum angular velocity resulting from 1-inch pedal inputs with the ASE "on" was 9 degrees per second attained in 1.1 seconds. Motions with ASE "on" were similar to those with the ASE inoperative. The high damping provided by the ASE did not prevent adequate maneuvering capability.

2.2.6 AUTOMATIC STABILIZATION EQUIPMENT MALFUNCTIONS

2.2.6.1 Objective

The objective of these tests was to determine the helicopter's reaction to an ASE failure and the pilot effort required to control this reaction.

2.2.6.2 Method

Two types of failures were analyzed: hard-overs and feedback circuit failures (oscillating hard-overs). A remote panel was provided by the aircraft manufacturer to simulate the desired type of failure.

Two types of pilot response were utilized for this test:

a. The controls were held fixed until recovery became necessary.

b. An immediate recovery was attempted upon sensing an ASE failure.

2.2.6.2.1 Hard-overs

ASE servo-hard-overs may result from any of the following equipment malfunctions:

a. A broken feedback link or pilot valve.
b. Loss of adjustment of a connecting linkage or pilot valve.
c. Improper action of the feedback linkage preventing proper servo follow-up.

In the first two types of malfunctions the proper piston of the affected channel is driven to its extreme position. In the third case a constant force drives the cyclic control stick to its extreme position.

An actual system hard-over is generated by a step-type ASE control input that has the magnitude of the maximum authority (20 percent) of the ASE system. The aircraft motion should be similar to that resulting from a pilot-induced, step-type control input of the same magitude with the ASE inoperative.

2.2.6.2.2 Oscillating Hard-overs (Feedback Circuit Failures)

A feedback circuit failure will cause the affected control to oscillate from the ASE maximum-authority limit in one direction to the ASE maximum-authority limit in the other direction.

2.2.6.3 Results

Time history illustrations of these results are presented in Figures No. 60 through 68, Section 3, Appendix I.

2.2.6.4 Analysis

2.2.6.4.1 Hard-overs

Analysis of the data indicated that the remote simulator panel did not provide true hard-overs during this test. The inputs generated by the panel were initially of the proper magnitude but slowly returned to the trim position after approximately 1 second. The helicopter reaction was similar to that resulting from a 10 percent cyclic or a 20 percent pedal-pulse input instead of the step-type control movement. In order to evaluate properly the resulting motions of the CH-37B to ASE failures that result in hard-overs, therefore, it was necessary to analyze both the results from the simulator panel and the results from the pilot-induced step-type control inputs.

From the simulator panel results it was found that the initial motion was in the same direction as the control movement that resulted from the failure. With the controls fixed the reaction was usually a long-period, lightly damped oscillation. The only time it was necessary for the pilot to initiate immediate recovery was following a forward cyclic failure at high speed. In this case the motion was a divergent pitch-down and recovery was initiated 2-1/2 seconds after the failure. Recovery was accomplished without excessive control inputs and before extreme attitudes resulted. When an immediate recovery was initiated the trim attitude could be maintained with only small corrections.

For a pilot induced hard-over, which was a 1-inch step input with the ASE inoperative, immediate corrective action was required to prevent excessive rates and extreme attitudes from developing. Time histories are presented in Figures No. 40 through 59, Section 3, Appendix I.

2.2.6.4.2 ASE Feedback Circuit Failures (Oscillating Hard-overs) (Reference Figures No. 68 through 73, Section 3, Appendix I)

The helicopter responded to a feedback circuit failure by oscillating about the failed axis. Rates and angular accelerations were large in all cases; however, the directions reversed too quickly to allow large attitude variations. A feedback circuit failure in the directional channel resulted in rates and accelerations that were of sufficient magnitude to create personal discomfort and concern about the structural integrity of the aircraft.

Pilot attempts to override the control inputs and maintain attitude resulted in an amplification of the helicopter motions. This was apparently caused by closed-loop control response due to pilot reaction time. The best pilot reaction to a feedback circuit failure was to hold the control fixed and immediately turn off the ASE.

2.2.6.4.3 Three-axis Hard-overs

The helicopter reaction to a three-axis hard-over was investigated by actuating the two-position "Override Check" switch during flight. This resulted in a combined nose-down, left-roll, and left-yaw maneuver (presented as a time history in Figure No. 74, Section 3, Appendix I). Actuation of the switch in the opposite direction resulted in a combined nose-up, right-roll, and right-yaw maneuver.

2.2.6.4.4 Actual Malfunctions

Several actual vibrational disturbances, one of which is presented as a time history in Figure No. 75, Section 3, Appendix I, were encountered during testing. The malfunction that caused these disturbances was never determined.

It was not possible to determine whether the malfunction is peculiar to this installation or is inherent in all CH-37B helicopters.

2.2.7 FLIGHT CONTROL SYSTEM EVALUATION

2.2.7.1 Objective

The objective of these tests was to determine the force gradient and friction forces present in the control system.

2.2.7.2 Method

These tests were performed with the helicopter on the ground with the rotor stationary. During the tests, the utility hydraulic system, the main servos, and the ASE servos were operated in a manner that simulated various normal flight emergency conditions.

2.2.7.3 Results

The results of these tests are presented in Table 5.

TABLE 5. [illegible]

Utility Hydraulic System	Main Servos	[illegible]	[illegible] lb	[illegible]	[illegible]
Off	[illegible]	[illegible]	5.5	[illegible]	[illegible]
On	On	[illegible]	[illegible]	[illegible]	[illegible]
On	On	On	[illegible]	[illegible]	[illegible]

2.2.7.4 Analysis

Longitudinal and lateral breakout forces were satisfactory and there was no apparent dead-band region. Incorporation of the ASE servo in the CH-37B reduced the forces and was a decided improvement over the CH-37A with all systems operating. With the stick trim turned "off" and all servos operating, less than 1 pound of force was required to move the cyclic control stick through full travel.

The high directional control friction forces were unsatisfactory. The values recorded for the CH-37B were greater than those reported for the CH-37A in the report AFFTC-TR-60-15 (Reference 1.1.f). These high pedal forces, in addition to the high sensitivity, increased the tendency for the pilot to over-control and made precision flying difficult especially while hovering.

SECTION 3

APPENDIX I

TEST DATA

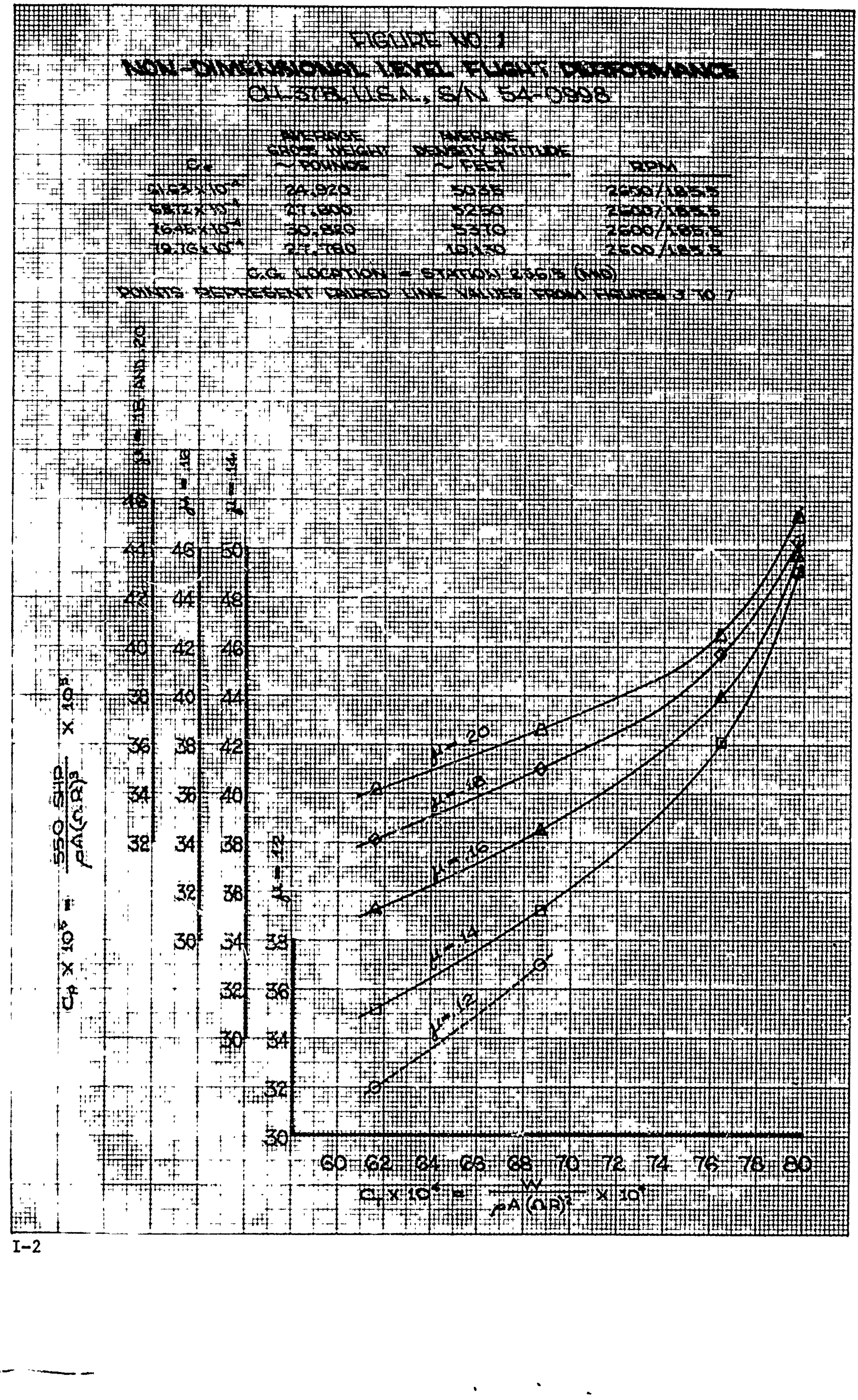


FIGURE NO. 1
NON-DIMENSIONAL LEVEL FLIGHT PERFORMANCE
CH-37B, U.S.A., S/N 54-0998
AVERAGE GROSS WEIGHT ~ POUNDS
AVERAGE DENSITY ALTITUDE ~ FEET
RPM
24,920
27,800
30,820
5250
5370
10,130
2600/185.5
C.G. LOCATION = STATION 256.5 (MID)
POINTS REPRESENT FAIRED LINE VALUES FROM FIGURES 3 TO 7
μ = .20
μ = .18
μ = .16
μ = .14
μ = .12
$C_P \times 10^5 = \frac{550\ SHP}{\rho A(\Omega R)^3} \times 10^5$
$C_T \times 10^4 = \frac{W}{\rho A(\Omega R)^2} \times 10^4$
60 62 64 66 68 70 72 74 76 78 80

FIGURE NO. 2

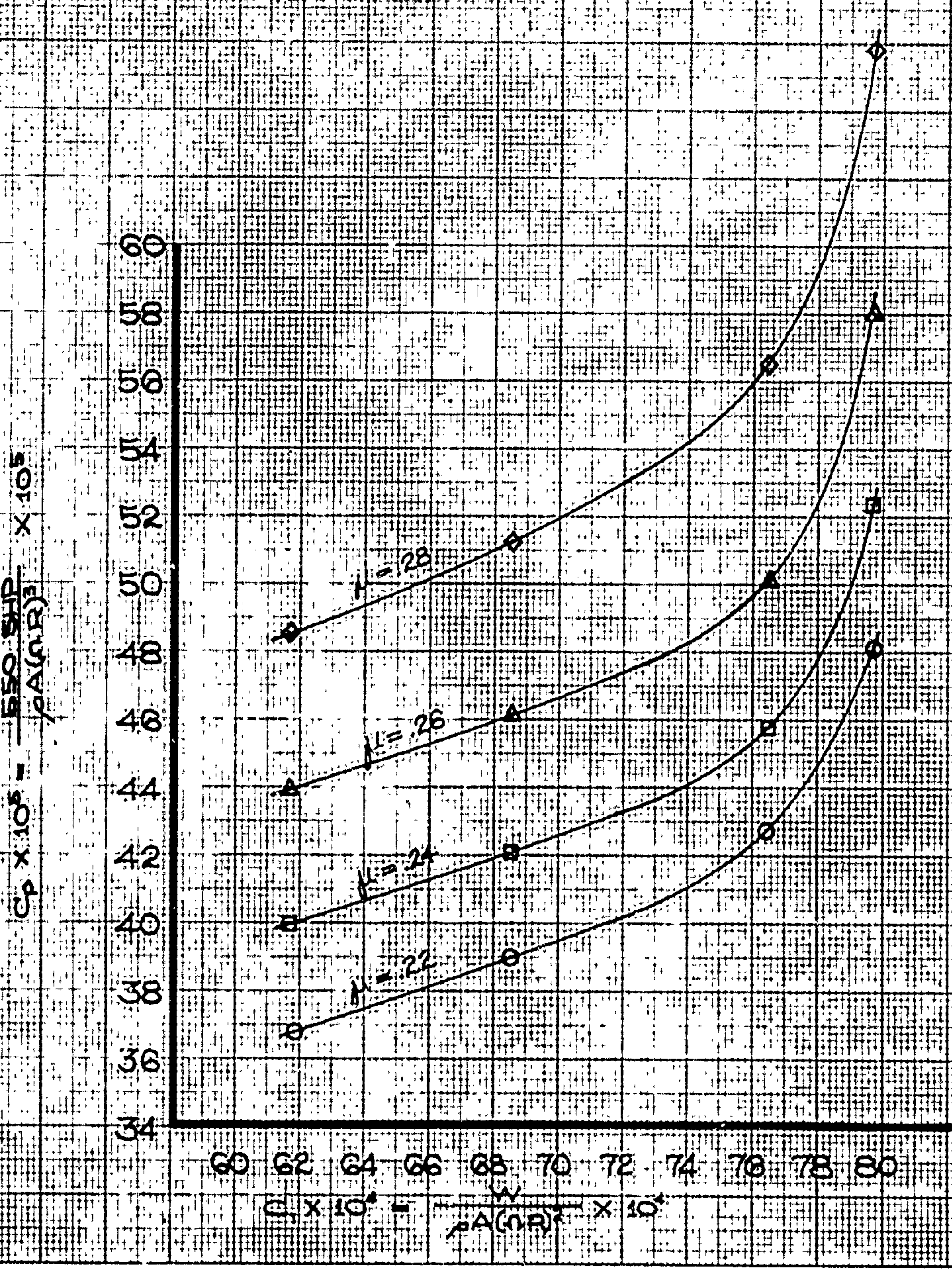
NON-DIMENSIONAL LEVEL FLIGHT PERFORMANCE

CH-37B, U.S.A., S/N 54-0998

C_T	AVERAGE GROSS WEIGHT ~ POUNDS	AVERAGE DENSITY ALTITUDE ~ FEET	RPM
61.63×10^{-4}	24,920	5035	2600/185.5
68.72×10^{-4}	27,800	5250	2600/185.5
76.45×10^{-4}	30,820	5370	2600/185.5
79.76×10^{-4}	27,780	10,130	2600/185.5

C.G. LOCATION = STATION 238.5 (MID)

POINTS REPRESENT FAIRED LINE VALUES FROM FIGURES 3 TO 7



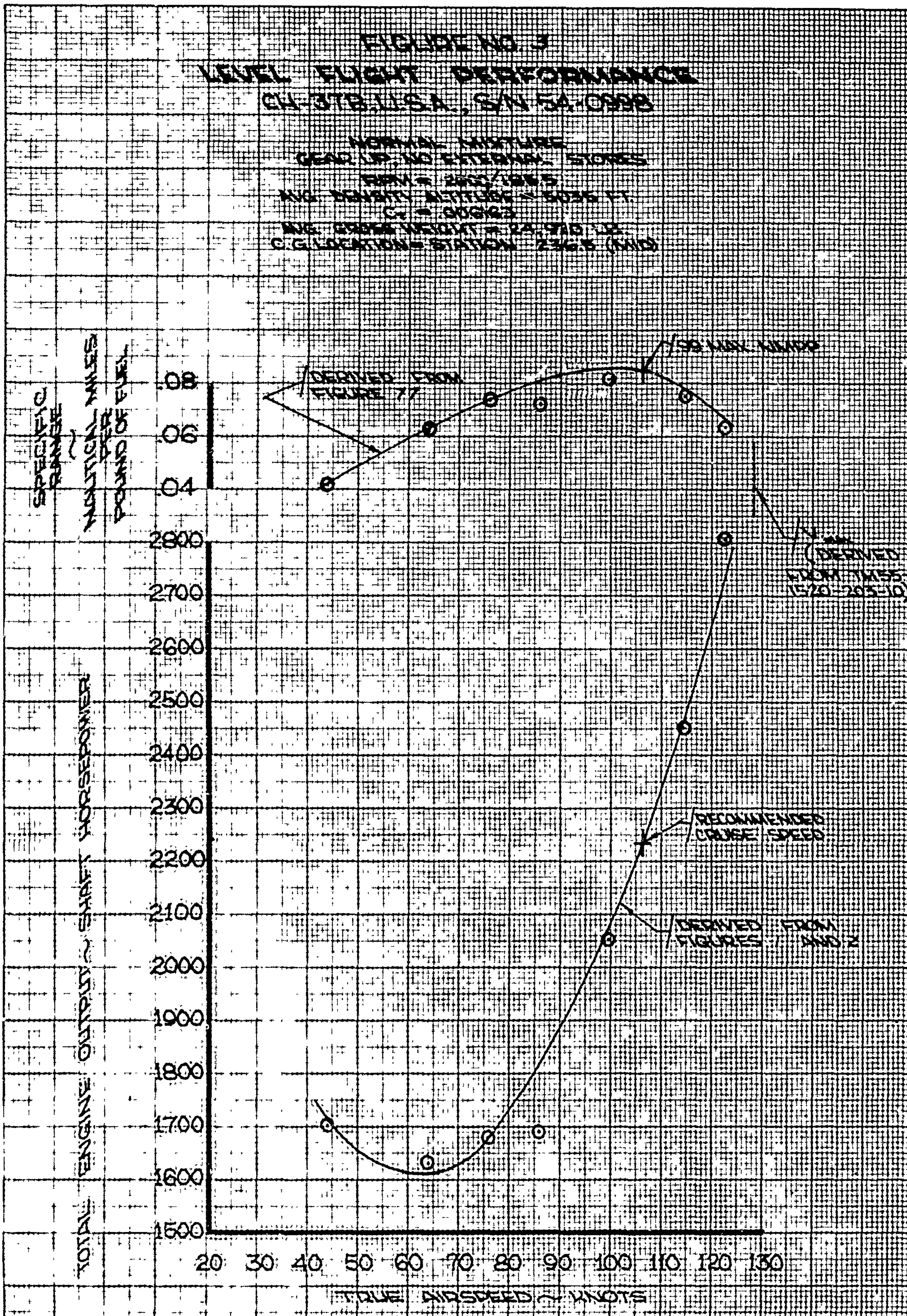


FIGURE NO. 3
LEVEL FLIGHT PERFORMANCE
CH-37B, U.S.A., S/N 54-0998
NORMAL MIXTURE
GEAR UP, NO EXTERNAL STORES
C.G. LOCATION = STATION 236.5 (MID)
DERIVED FROM FIGURE 7
.99 MAX. NMPP
DERIVED FROM TM55-1520-203-10
RECOMMENDED CRUISE SPEED
DERIVED FROM FIGURES AND 2
SPECIFIC RANGE ~ NAUTICAL MILES PER POUND OF FUEL
.08
.06
.04
TOTAL ENGINE OUTPUT ~ SHAFT HORSEPOWER
2800
2700
2600
2500
2400
2300
2200
2100
2000
1900
1800
1700
1600
1500
20 30 40 50 60 70 80 90 100 110 120 130
TRUE AIRSPEED ~ KNOTS

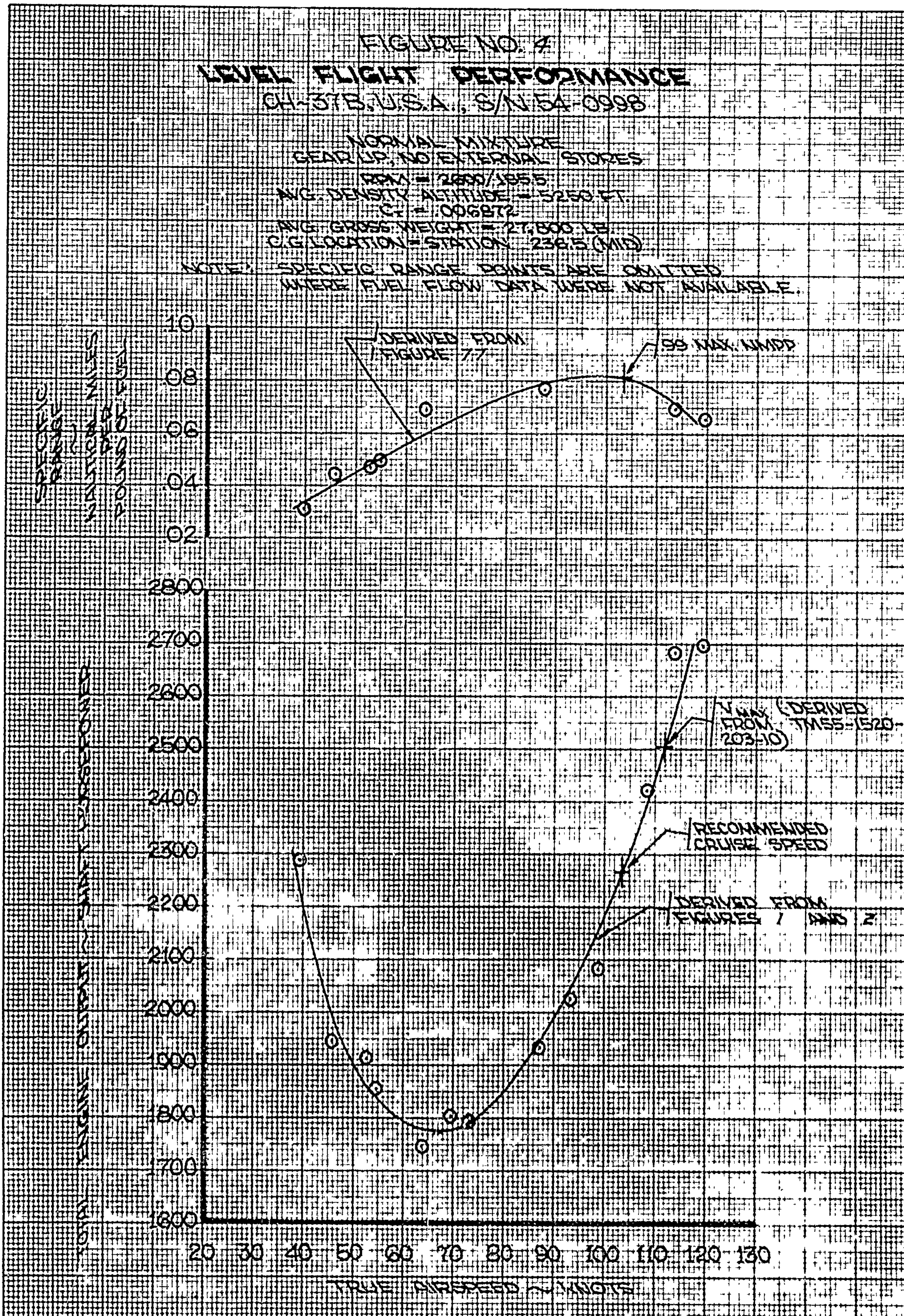


FIGURE NO. 4
LEVEL FLIGHT PERFORMANCE
CH-37B, U.S.A., S/N 54-0998
NORMAL MIXTURE
GEAR UP, NO EXTERNAL STORES
RPM = 2600/1955
AVG. DENSITY ALTITUDE = 5250 FT.
C_T = .006872
AVG. GROSS WEIGHT = 27,800 LB.
C.G. LOCATION = STATION 236.5 (MID)
NOTE: SPECIFIC RANGE POINTS ARE OMITTED
WHERE FUEL FLOW DATA WERE NOT AVAILABLE.
DERIVED FROM FIGURE 77
99 MAX. NMPP
V_{MAX} (DERIVED FROM TM55-1520-203-10)
RECOMMENDED CRUISE SPEED
DERIVED FROM FIGURES 1 AND 2
.10
.08
.06
.04
.02
2800
2700
2600
2500
2400
2300
2200
2100
2000
1900
1800
1700
1600
20 30 40 50 60 70 80 90 100 110 120 130
TRUE AIRSPEED ~ KNOTS

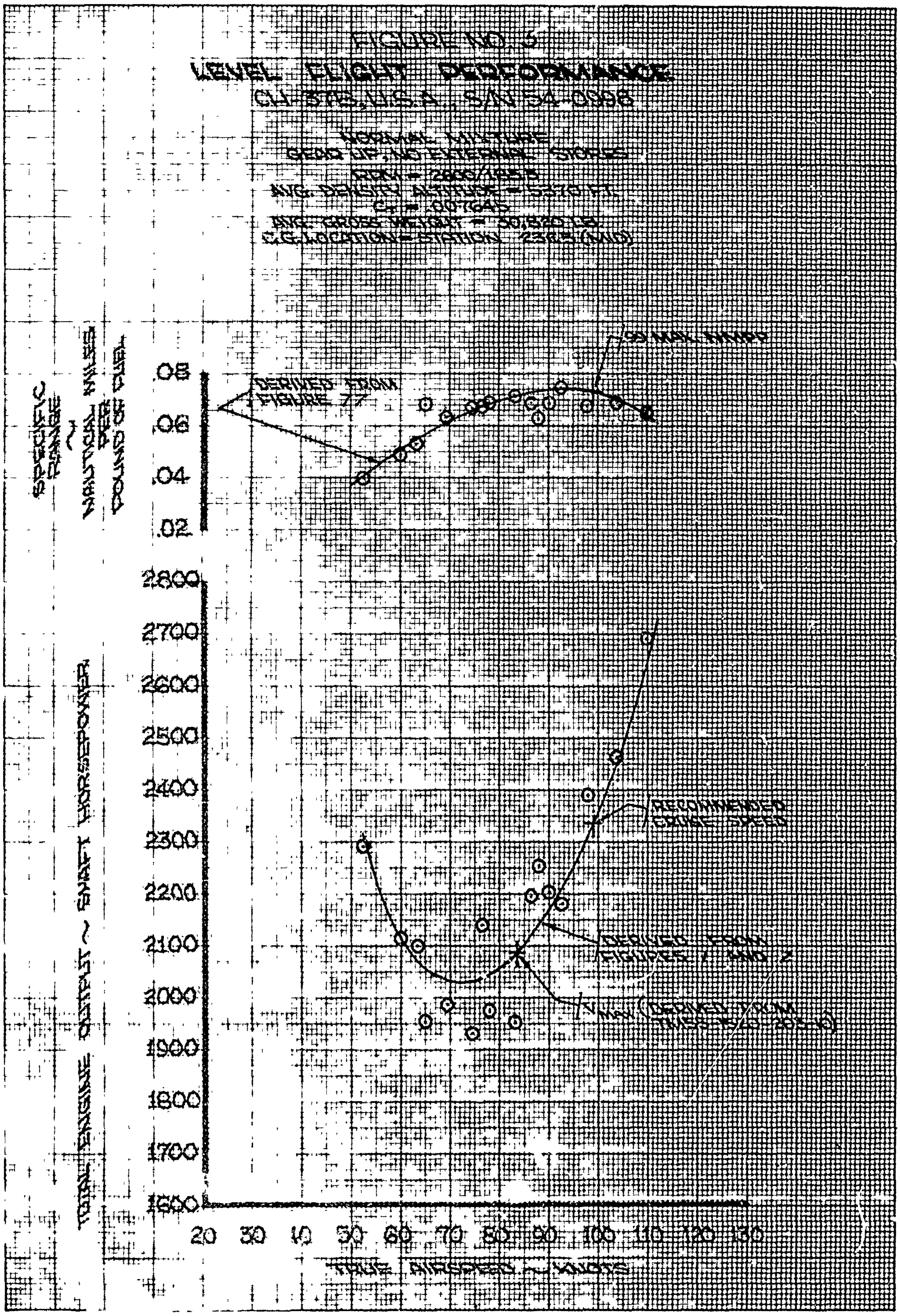


FIGURE NO. 5
LEVEL FLIGHT PERFORMANCE
CH-37B, U.S.A., S/N 54-0998
NORMAL MIXTURE
GEAR UP, NO EXTERNAL STORES
AVG. GROSS WEIGHT = 30,820 LB
DERIVED FROM FIGURE 7
99 MAX. NMPP
RECOMMENDED CRUISE SPEED
SPECIFIC RANGE ~ NAUTICAL MILES PER POUND OF FUEL
TOTAL ENGINE OUTPUT ~ SHAFT HORSEPOWER
TRUE AIRSPEED ~ KNOTS
.08
.06
.04
.02
2800
2700
2600
2500
2400
2300
2200
2100
2000
1900
1800
1700
1600
20 30 40 50 60 70 80 90 100 110 120 130

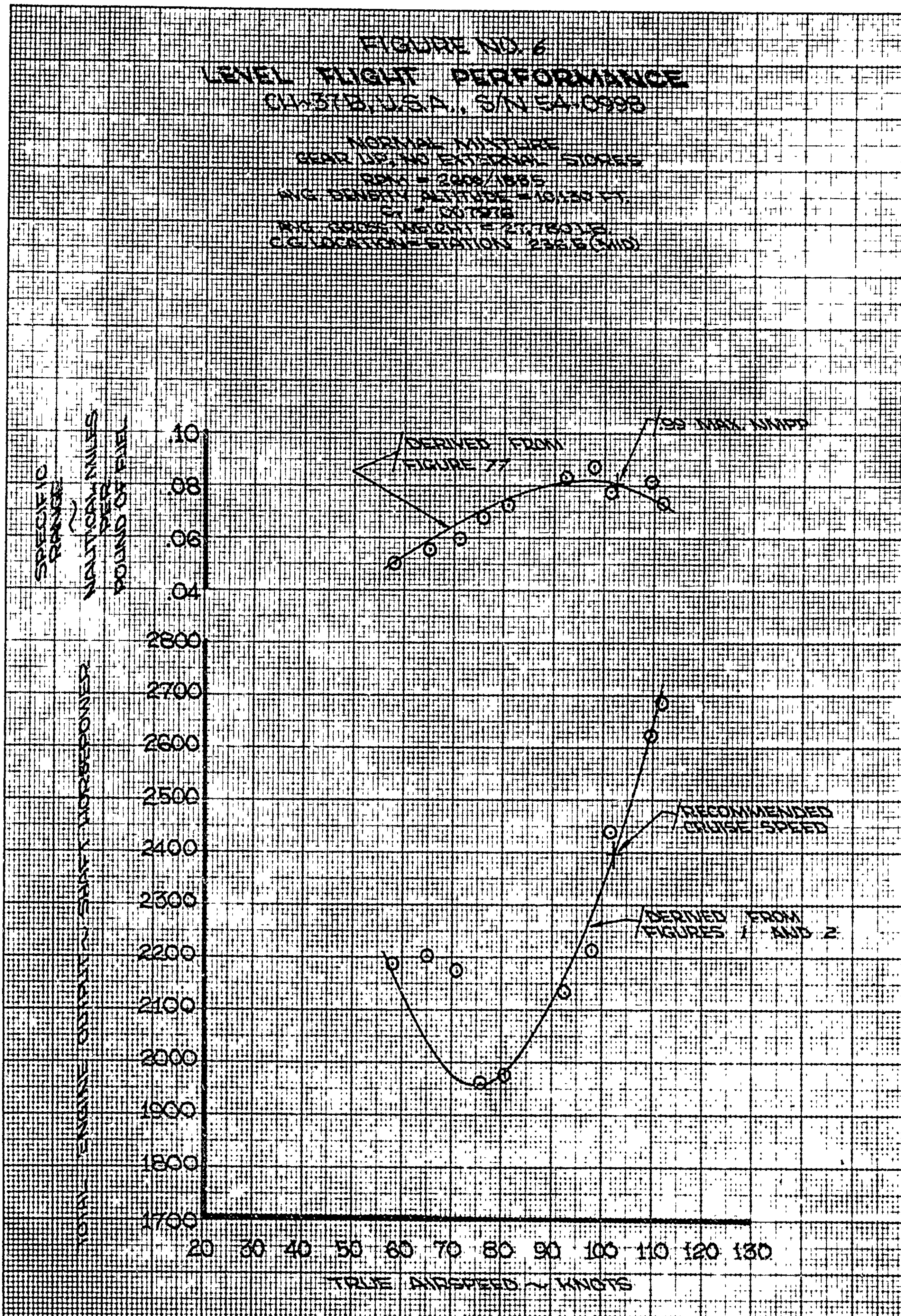


FIGURE NO. 6
LEVEL FLIGHT PERFORMANCE
NORMAL MIXTURE
GEAR UP, NO EXTERNAL STORES
SPECIFIC RANGE ~ NAUTICAL MILES PER POUND OF FUEL
.10
.08
.06
.04
DERIVED FROM FIGURE 77
99 MAX. NMPP
TOTAL ENGINE OUTPUT ~ SHAFT HORSEPOWER
2800
2700
2600
2500
2400
2300
2200
2100
2000
1900
1800
1700
RECOMMENDED CRUISE SPEED
DERIVED FROM FIGURES 1 AND 2
20 30 40 50 60 70 80 90 100 110 120 130
TRUE AIRSPEED ~ KNOTS

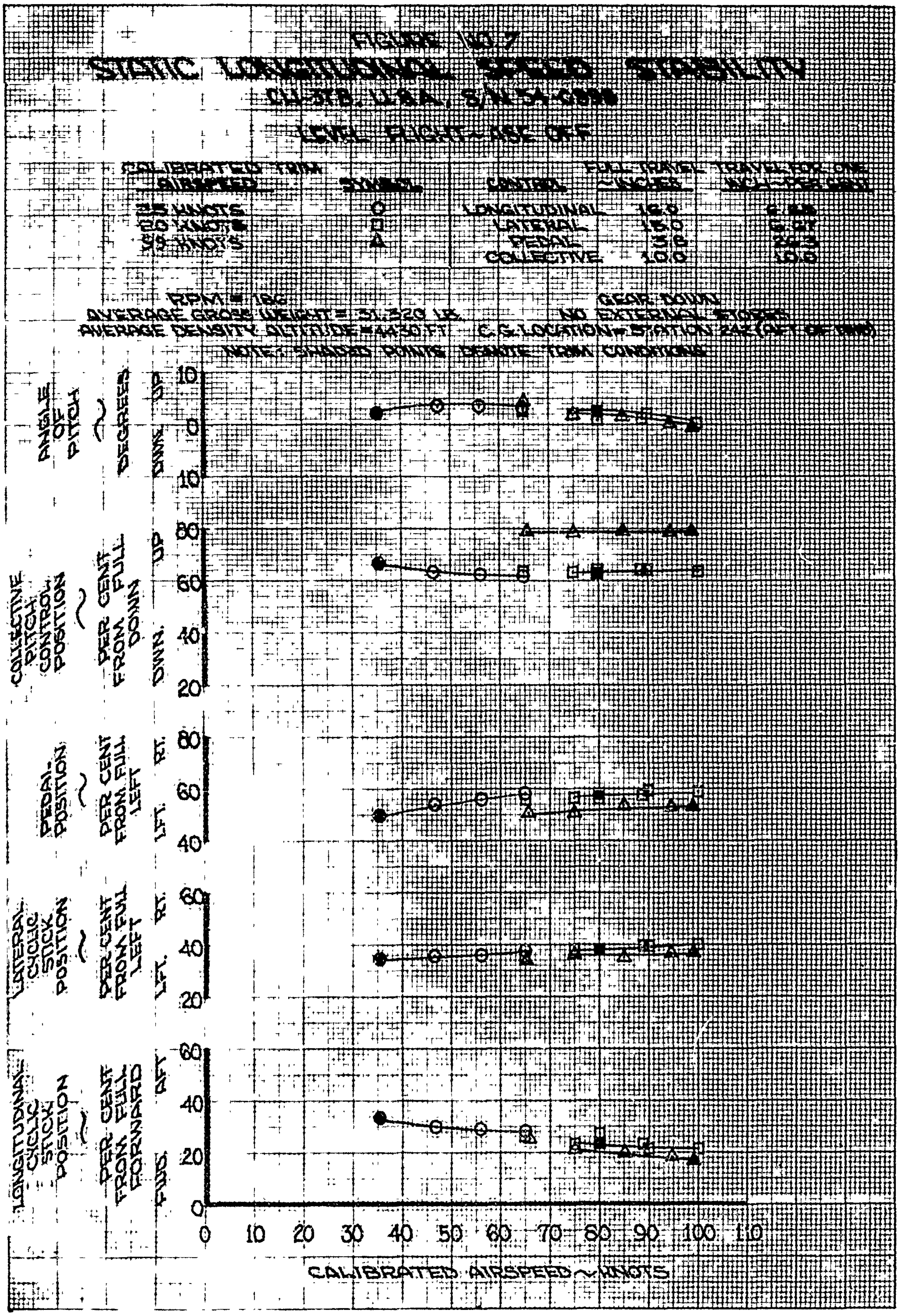
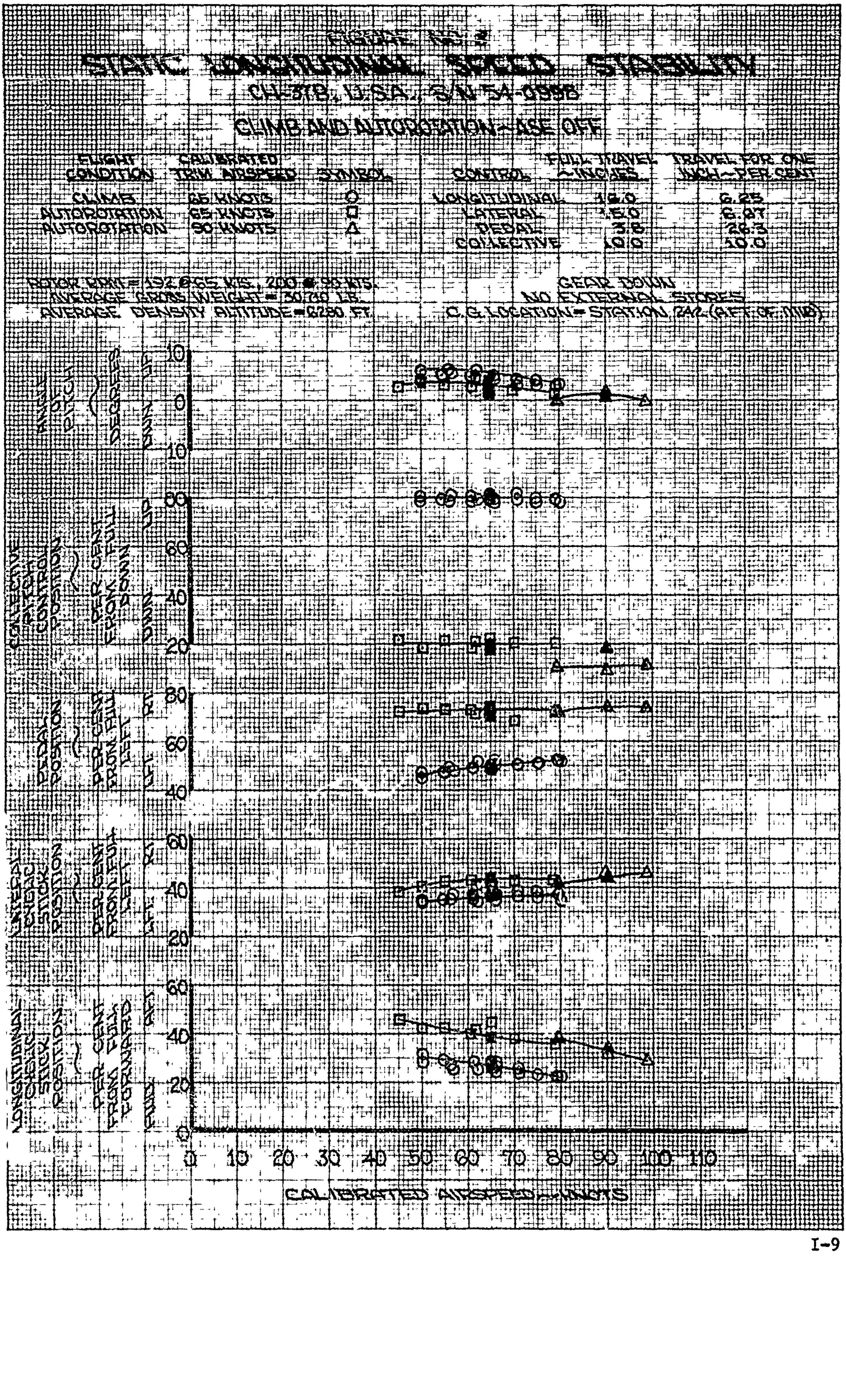


FIGURE NO. 7
STATIC LONGITUDINAL SPEED STABILITY
LEVEL FLIGHT ~ ASE OFF
CALIBRATED TRIM AIRSPEED
SYMBOL
CONTROL
FULL TRAVEL ~ INCHES
TRAVEL FOR ONE
35 KNOTS
80 KNOTS
99 KNOTS
LONGITUDINAL
LATERAL
PEDAL
COLLECTIVE
10.0
10.0
RPM = 186
GEAR DOWN
AVERAGE GROSS WEIGHT = 31,320 LB.
NO EXTERNAL STORES
AVERAGE DENSITY ALTITUDE = 4430 FT.
NOTE: SHADED POINTS DENOTE TRIM CONDITIONS
ANGLE OF PITCH ~ DEGREES
DWN.
UP
COLLECTIVE PITCH CONTROL POSITION ~ PER CENT FROM FULL DOWN
PEDAL POSITION ~ PER CENT FROM FULL LEFT
LFT.
RT.
LATERAL CYCLIC STICK POSITION ~ PER CENT FROM FULL LEFT
LONGITUDINAL CYCLIC STICK POSITION ~ PER CENT FROM FULL FORWARD
FWD.
AFT
CALIBRATED AIRSPEED ~ KNOTS


STATIC LONGITUDINAL SPEED STABILITY
CH-37B, U.S.A., S/N 54-0998
CLIMB AND AUTOROTATION ~ ASE OFF
FLIGHT CONDITION | CALIBRATED TRIM AIRSPEED | SYMBOL
CLIMB | 65 KNOTS | ○
AUTOROTATION | 65 KNOTS | □
AUTOROTATION | 90 KNOTS | △
CONTROL | FULL TRAVEL ~ INCHES | TRAVEL FOR ONE INCH ~ PER CENT
LONGITUDINAL | 16.0 | 6.25
LATERAL | 15.0 | 6.67
PEDAL | 3.8 | 26.3
COLLECTIVE | 10.0 | 10.0
AVERAGE GROSS WEIGHT = 30,700 LB.
AVERAGE DENSITY ALTITUDE = 6280 FT.
GEAR DOWN
NO EXTERNAL STORES
C.G. LOCATION = STATION 242 (AFT OF MID)
ANGLE PITCH ~ DEGREES
UP
DOWN
COLLECTIVE PITCH CONTROL POSITION ~ PER CENT FROM FULL DOWN
UP
DOWN
PEDAL POSITION ~ PER CENT FROM FULL LEFT
RT
LFT
LATERAL CYCLIC STICK POSITION ~ PER CENT FROM FULL LEFT
RT
LFT
LONGITUDINAL CYCLIC STICK POSITION ~ PER CENT FROM FULL FORWARD
AFT
FWD
CALIBRATED AIRSPEED ~ KNOTS
0 10 20 30 40 50 60 70 80 90 100 110

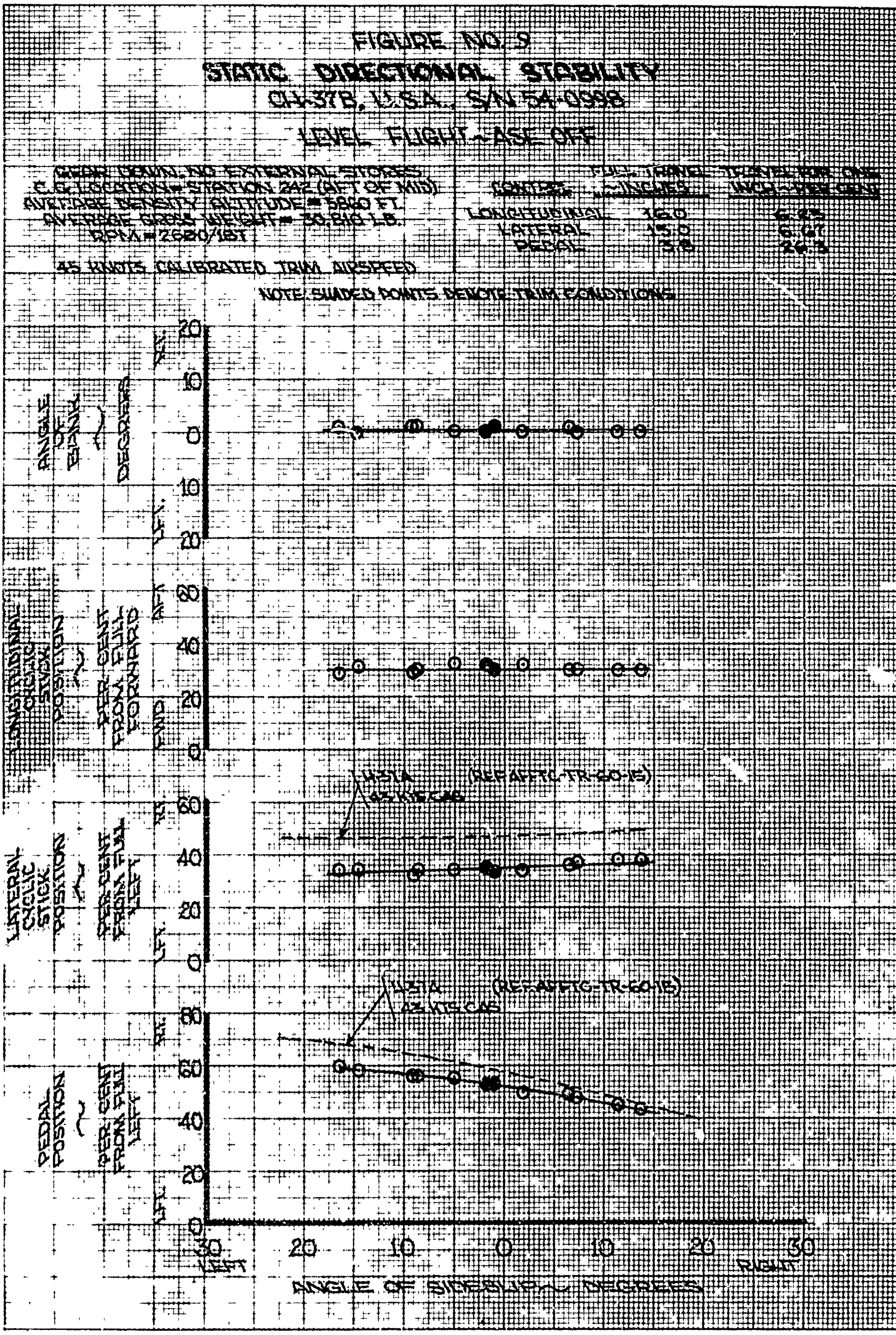


FIGURE NO. 9
STATIC DIRECTIONAL STABILITY
CH-37B, U.S.A., S/N 54-0998
LEVEL FLIGHT ~ ASE OFF
GEAR DOWN, NO EXTERNAL STORES
C.G. LOCATION = STATION 242 (AFT OF MID)
AVERAGE DENSITY ALTITUDE = 5860 FT.
AVERAGE GROSS WEIGHT = 30,810 LB.
RPM = 2620/181
CONTROL
FULL TRAVEL ~ INCHES
TRAVEL FOR ONE INCH ~ PER CENT
LONGITUDINAL 16.0 6.25
LATERAL 15.0 6.67
PEDAL 3.8 26.3
45 KNOTS CALIBRATED TRIM AIRSPEED
NOTE: SHADED POINTS DENOTE TRIM CONDITIONS
ANGLE OF BANK ~ DEGREES
LONGITUDINAL CYCLIC STICK POSITION ~ PER CENT FROM FULL FORWARD
LATERAL CYCLIC STICK POSITION ~ PER CENT FROM FULL LEFT
PEDAL POSITION ~ PER CENT FROM FULL LEFT
H-37A 45 KTS CAS (REF AFFTC-TR-60-15)
H-37A 45 KTS CAS (REF AFFTC-TR-60-15)
ANGLE OF SIDESLIP ~ DEGREES
LEFT
RIGHT

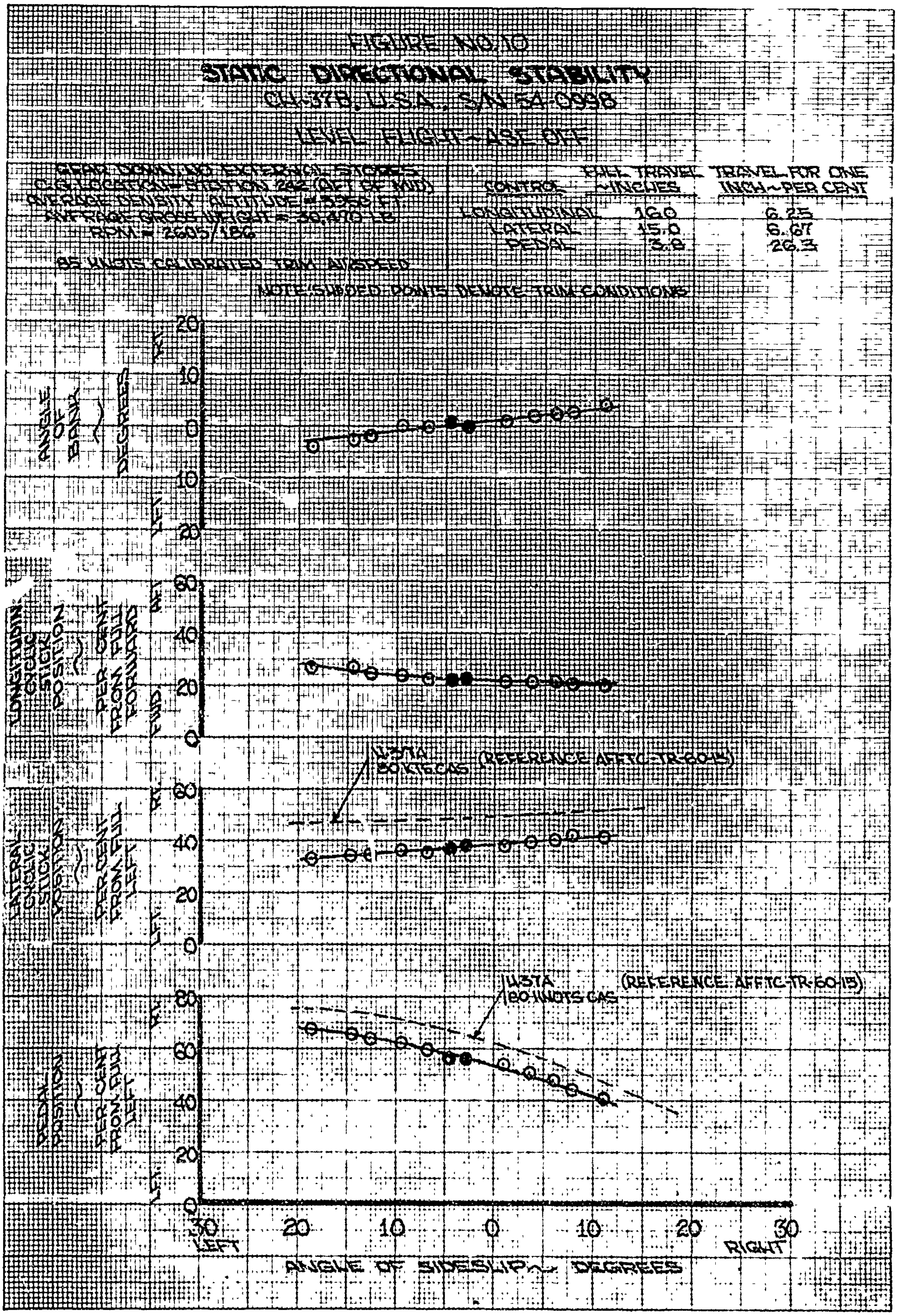


FIGURE NO. 10
STATIC DIRECTIONAL STABILITY
CH-37B, U.S.A., S/N 54-0998
LEVEL FLIGHT ~ ASE OFF
GEAR DOWN, NO EXTERNAL STORES
RPM = 2605/186
85 KNOTS CALIBRATED TRIM AIRSPEED
CONTROL
FULL TRAVEL ~INCHES
TRAVEL FOR ONE INCH ~ PER CENT
LONGITUDINAL 16.0 6.25
LATERAL 15.0 6.67
PEDAL 3.8 26.3
NOTE: SHADED POINTS DENOTE TRIM CONDITIONS
ANGLE OF BANK ~ DEGREES
LONGITUDINAL CYCLIC STICK POSITION ~ PER CENT FROM FULL FORWARD
LATERAL CYCLIC STICK POSITION ~ PER CENT FROM FULL LEFT
PEDAL POSITION ~ PER CENT FROM FULL LEFT
H-37A 80 KTS CAS (REFERENCE AFFTC-TR-60-15)
H-37A 80 KNOTS CAS (REFERENCE AFFTC-TR-60-15)
LEFT
RIGHT
AFT
FWD
ANGLE OF SIDESLIP ~ DEGREES

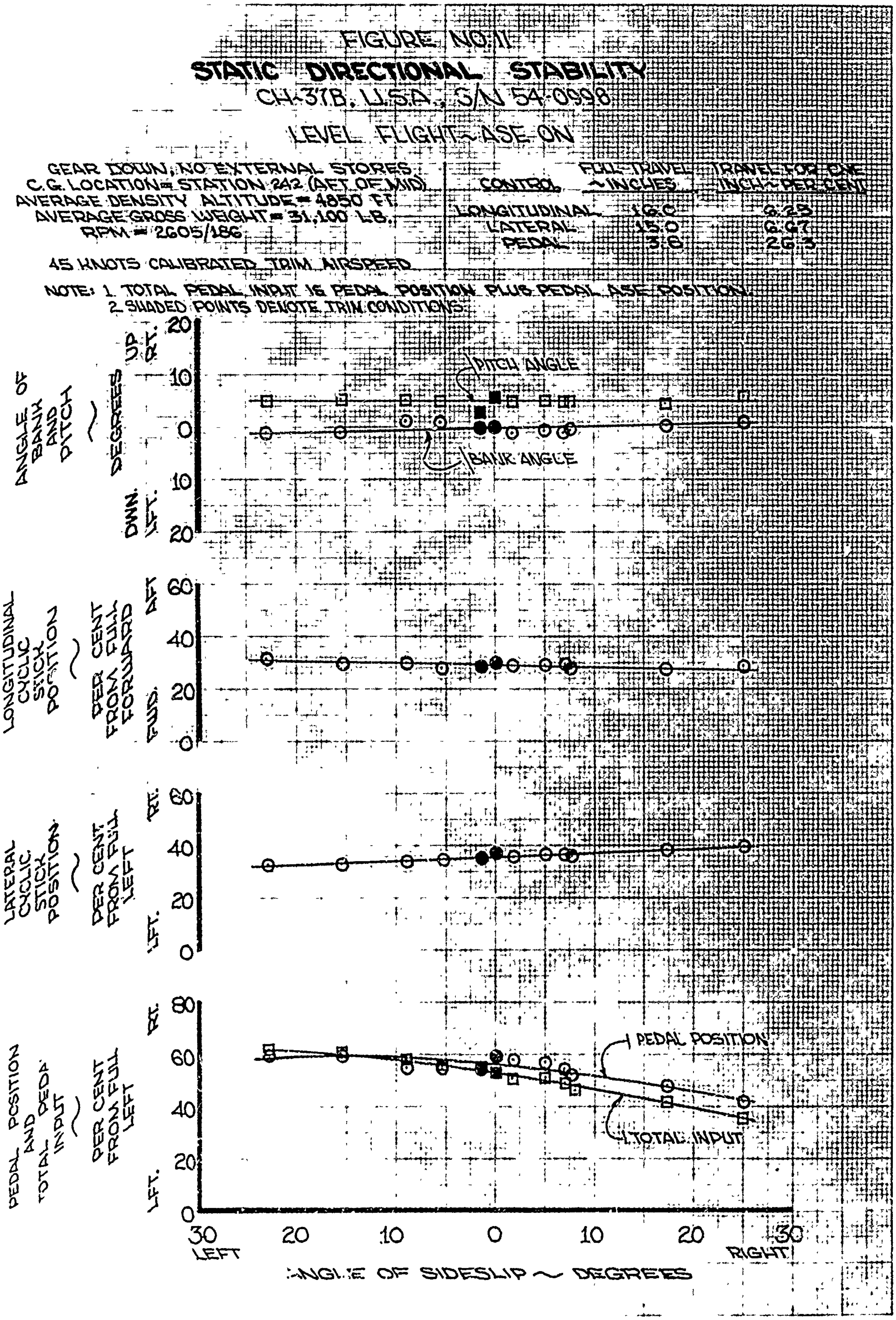


FIGURE NO.11
STATIC DIRECTIONAL STABILITY
CH-37B, U.S.A., S/N 54-0998
LEVEL FLIGHT ~ ASE ON
GEAR DOWN, NO EXTERNAL STORES
C.G. LOCATION = STATION 242 (AFT OF MID)
AVERAGE DENSITY ALTITUDE = 4850 FT.
AVERAGE GROSS WEIGHT = 31,100 LB.
RPM = 2605/186
45 KNOTS CALIBRATED TRIM AIRSPEED
CONTROL
FULL TRAVEL ~ INCHES
TRAVEL FOR ONE INCH ~ PER CENT
LONGITUDINAL
LATERAL
PEDAL
NOTE: 1. TOTAL PEDAL INPUT IS PEDAL POSITION PLUS PEDAL ASE POSITION.
2. SHADED POINTS DENOTE TRIM CONDITIONS.
ANGLE OF BANK AND PITCH ~ DEGREES
UP RT.
DWN. LFT.
PITCH ANGLE
BANK ANGLE
LONGITUDINAL CYCLIC STICK POSITION ~ PER CENT FROM FULL FORWARD
AFT
FWD.
LATERAL CYCLIC STICK POSITION ~ PER CENT FROM FULL LEFT
RT.
LFT.
PEDAL POSITION AND TOTAL PEDAL INPUT ~ PER CENT FROM FULL LEFT
PEDAL POSITION
TOTAL INPUT
LEFT
RIGHT
ANGLE OF SIDESLIP ~ DEGREES

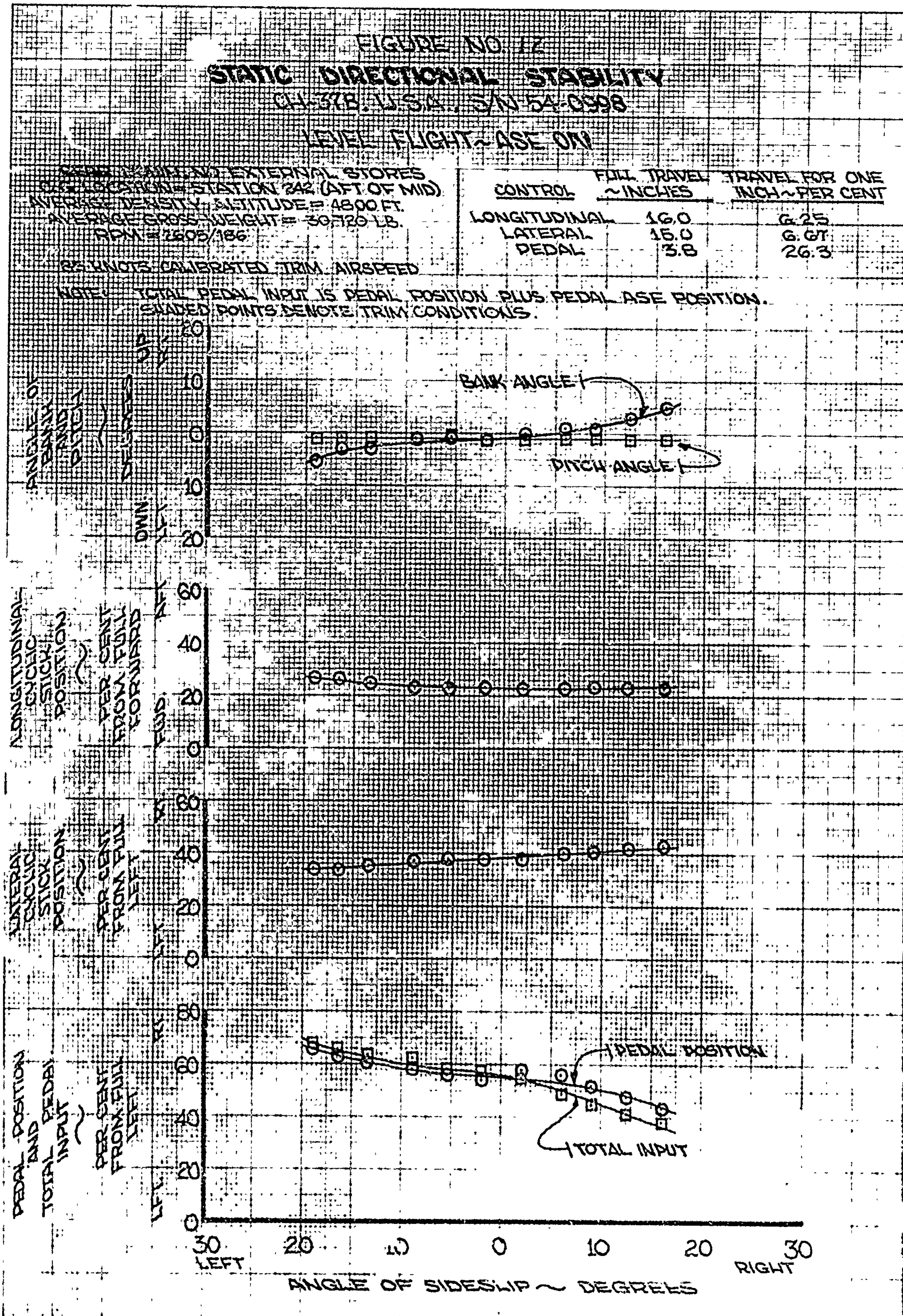


FIGURE NO. 12
STATIC DIRECTIONAL STABILITY
CH-37B, U.S.A., S/N 54-0998
LEVEL FLIGHT ~ ASE ON
NO EXTERNAL STORES
STATION 342 (AFT OF MID)
ALTITUDE = 4800 FT.
WEIGHT = 30,720 LB.
RPM = 2605/186
KNOTS CALIBRATED TRIM AIRSPEED
CONTROL
FULL TRAVEL ~INCHES
TRAVEL FOR ONE INCH ~ PER CENT
LONGITUDINAL 16.0 6.25
LATERAL 15.0 6.67
PEDAL 3.8 26.3
NOTE: TOTAL PEDAL INPUT IS PEDAL POSITION PLUS PEDAL ASE POSITION.
SHADED POINTS DENOTE TRIM CONDITIONS.
BANK ANGLE
PITCH ANGLE
ANGLE OF BANK AND PITCH ~ DEGREES
LONGITUDINAL CYCLIC STICK POSITION ~ PER CENT FROM FULL FORWARD
AFT
FWD
LATERAL CYCLIC STICK POSITION ~ PER CENT FROM FULL LEFT
RT
LFT
PEDAL POSITION AND TOTAL PEDAL INPUT ~ PER CENT FROM FULL LEFT
PEDAL POSITION
TOTAL INPUT
30 LEFT
20
10
0
10
20
30 RIGHT
ANGLE OF SIDESLIP ~ DEGREES

FIGURE NO. 13

STATIC DIRECTIONAL STABILITY

CH-37B, U.S.A., S/N 54-0998

AUTOROTATION ~ ASE OFF

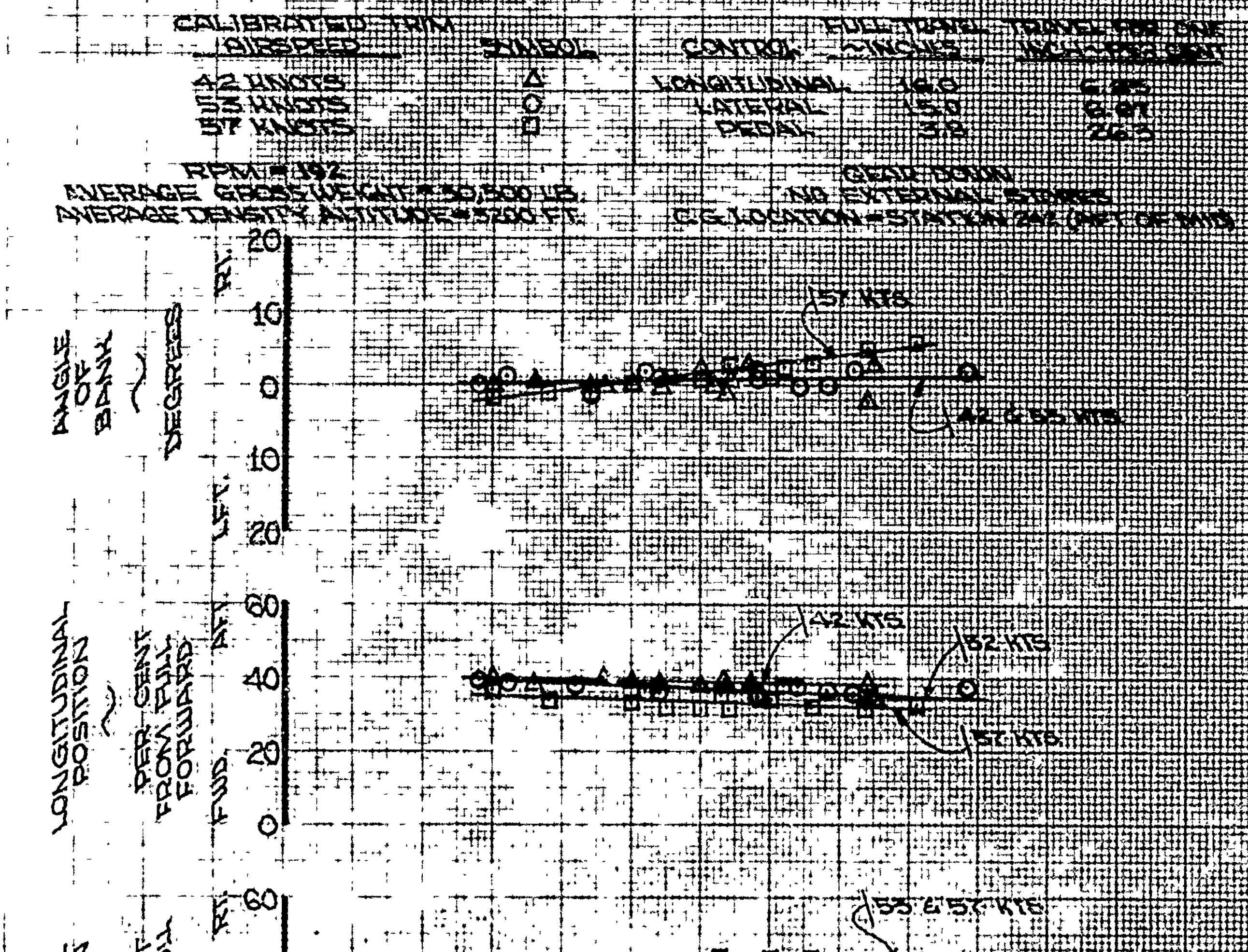


FIGURE NO. 14

STATIC DIRECTIONAL STABILITY

CH-37B, U.S.A., S/N 54-0998

AUTOROTATION ~ ASE ON

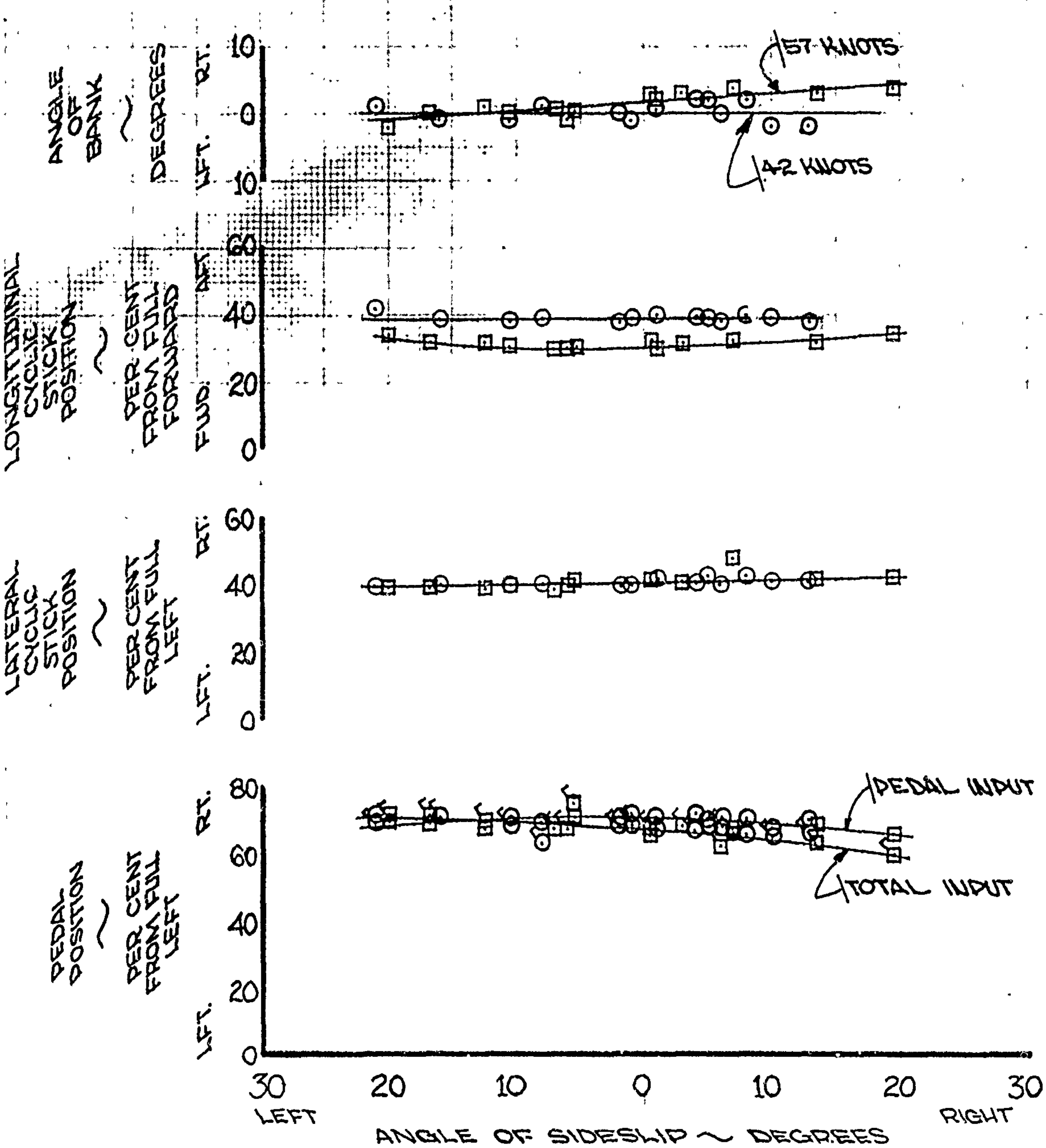
CALIBRATED TRIM AIRSPEED	SYMBOL
42 KNOTS	O
57 KNOTS	□

CONTROL	FULL TRAVEL ~INCHES	TRAVEL FOR ONE INCH ~ PER CENT
LONGITUDINAL	16.0	6.25
LATERAL	15.0	6.67
PEDAL	3.8	26.3

RPM = 190
AVERAGE GROSS WEIGHT = 30,590 LB.
AVERAGE DENSITY ALTITUDE = 4200 FT.

GEAR DOWN
NO EXTERNAL STORES
C.G. LOCATION = STATION 242 (AFT OF MID)

NOTE: FLAGGED SYMBOLS DENOTE TOTAL PEDAL INPUT WHICH IS PEDAL POSITION PLUS PEDAL ASE INPUT.



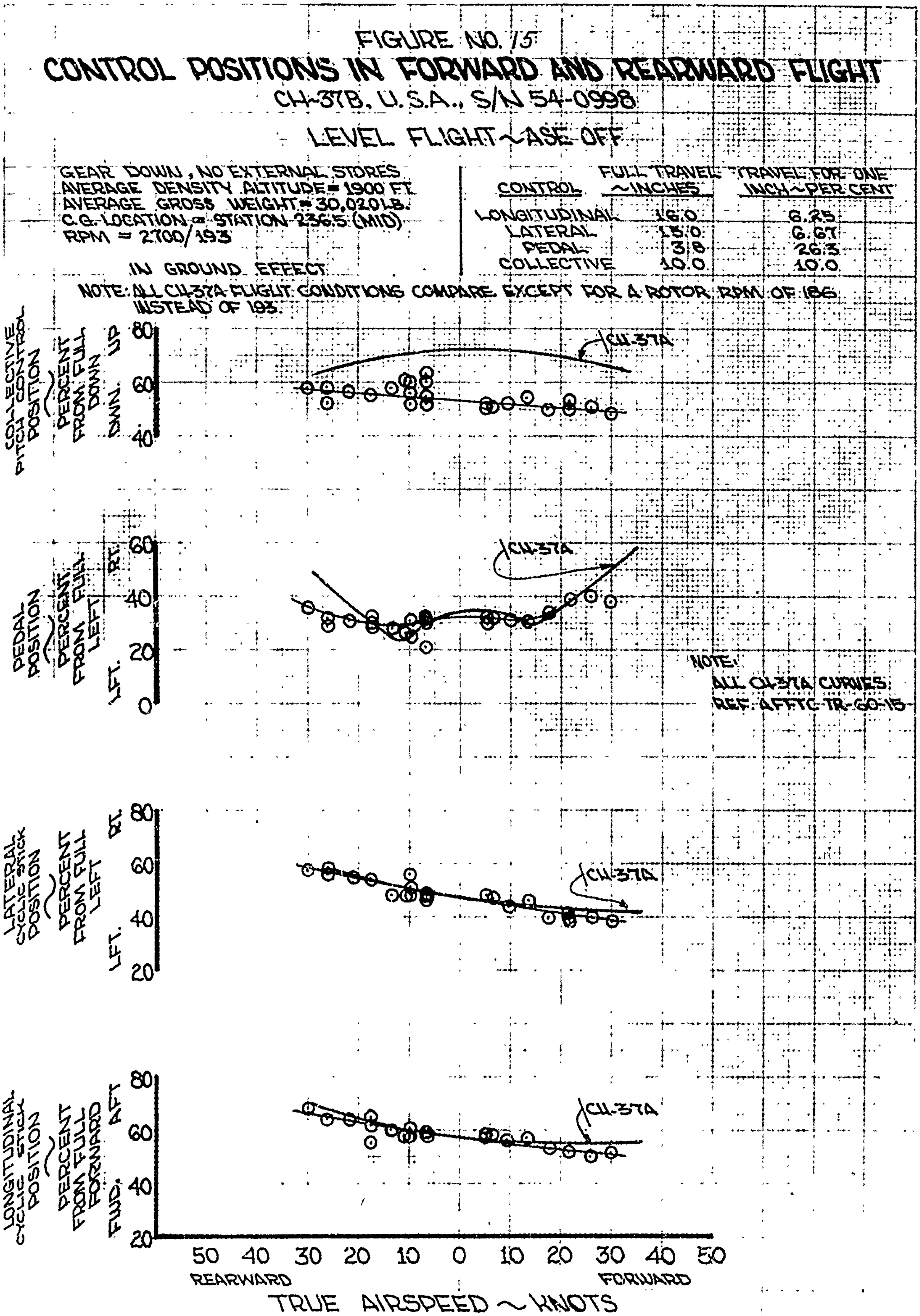


FIGURE NO. 15
CONTROL POSITIONS IN FORWARD AND REARWARD FLIGHT
CH-37B, U.S.A., S/N 54-0998
LEVEL FLIGHT ~ ASE OFF
GEAR DOWN, NO EXTERNAL STORES
AVERAGE DENSITY ALTITUDE = 1900 FT.
AVERAGE GROSS WEIGHT = 30,020 LB.
C.G. LOCATION = STATION 236.5 (MID)
RPM = 2700/193
IN GROUND EFFECT
CONTROL
FULL TRAVEL ~INCHES
TRAVEL FOR ONE INCH ~ PER CENT
LONGITUDINAL 16.0 6.25
LATERAL 15.0 6.67
PEDAL 3.8 26.3
COLLECTIVE 10.0 10.0
NOTE: ALL CH-37A FLIGHT CONDITIONS COMPARE EXCEPT FOR A ROTOR RPM OF 186 INSTEAD OF 193.
COLLECTIVE PITCH CONTROL POSITION ~ PERCENT FROM FULL DOWN
DWN. UP
CH-37A
PEDAL POSITION ~ PERCENT FROM FULL LEFT
LFT. RT.
NOTE:
ALL CH-37A CURVES REF. AFFTC-TR-60-15
LATERAL CYCLIC STICK POSITION ~ PERCENT FROM FULL LEFT
LONGITUDINAL CYCLIC STICK POSITION ~ PERCENT FROM FULL FORWARD
FWD. AFT
50 40 30 20 10 0 10 20 30 40 50
REARWARD
FORWARD
TRUE AIRSPEED ~ KNOTS

FIGURE NO. 16
RESPONSE TO A FWD. LONGITUDINAL PULSE - ASE OFF
CH-37B, U.S.A., S/N 54-0998

FULL LONGITUDINAL TRAVEL = 16 INCHES
C.G. LOCATION = STATION 242
AVG. GROSS WEIGHT = 31,090 LB.

TRIM CAS = 47 KNOTS
DENSITY ALTITUDE = 5960 FT.
RPM = 2605/186

LEVEL FLIGHT

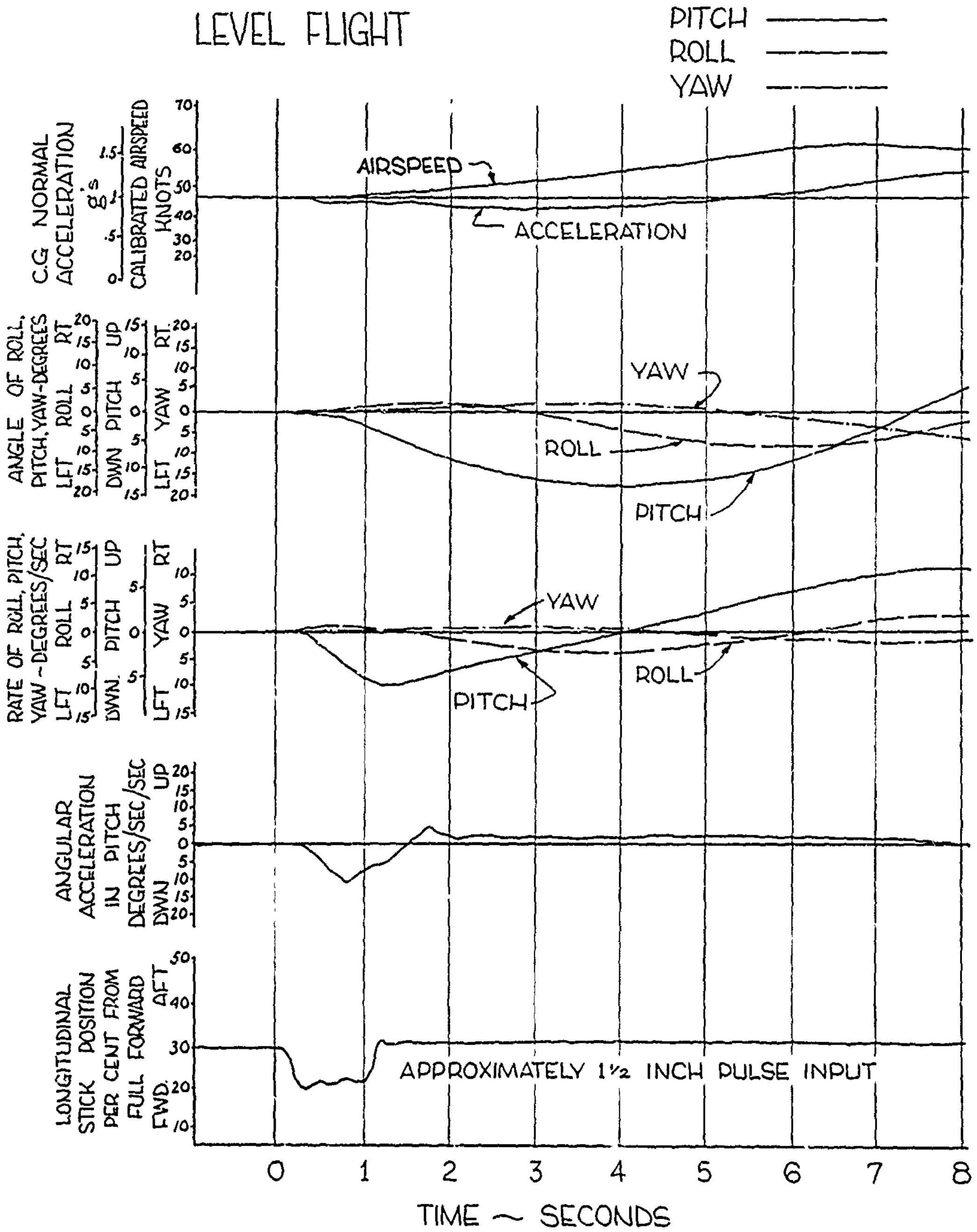


FIGURE NO. 17
RESPONSE TO AN AFT LONGITUDINAL PULSE-ASE OFF
CH-37B, U.S.A., S/N 54-0998

FULL LONGITUDINAL TRAVEL = 16 INCHES
C.G LOCATION = STATION 242
AVG GROSS WEIGHT = 31,050 LB.

TRIM CAS = 45 KNOTS
DENSITY ALTITUDE = 4980 FT.
RPM = 2630/188

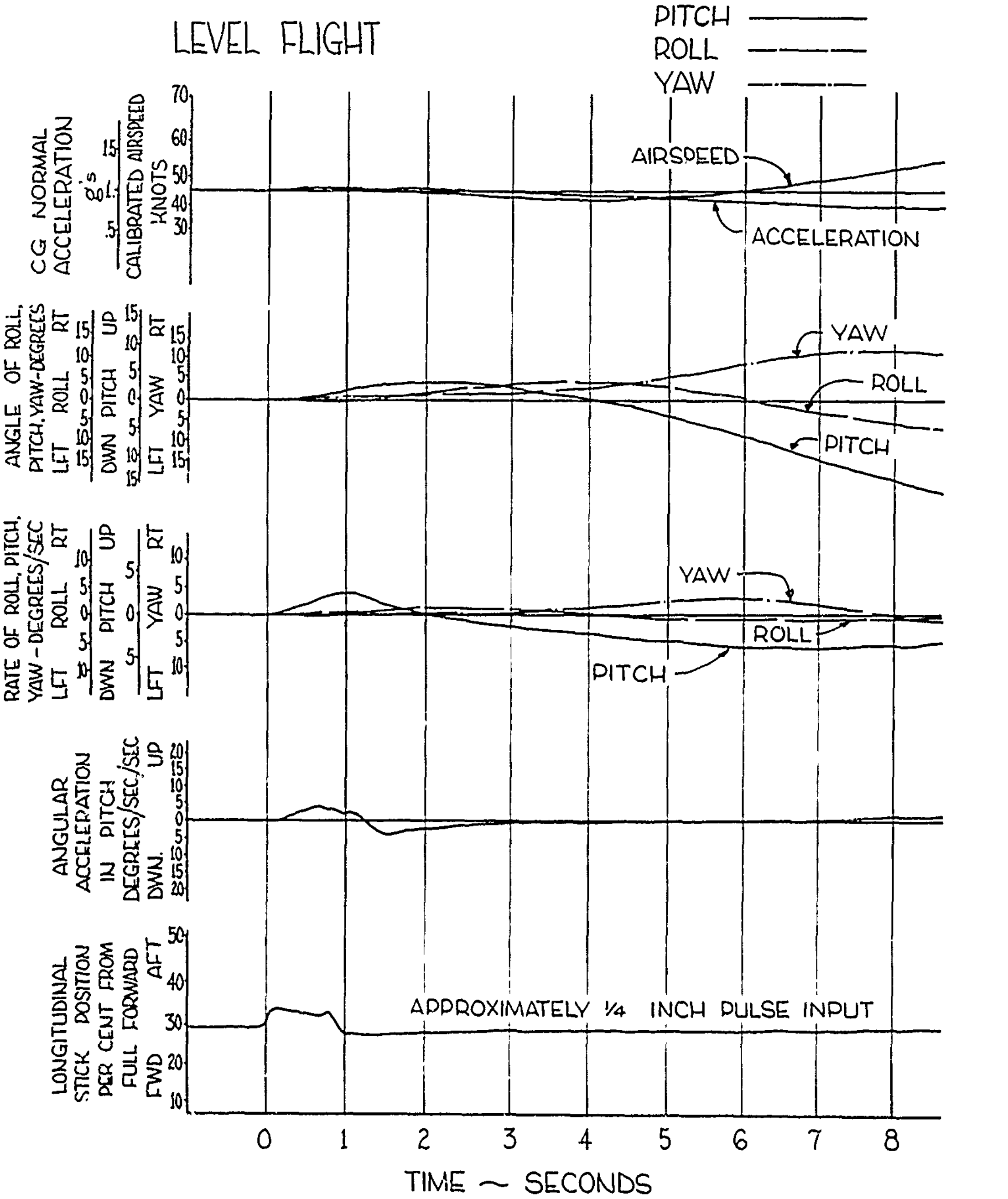


FIGURE NO. 18
RESPONSE TO AN AFT LONGITUDINAL PULSE-ASE OFF
CH-37B, U.S.A., S/N 54-0998

FULL LONGITUDINAL TRAVEL = 16 INCHES
C.G LOCATION = STATION 242
AVG. GROSS WEIGHT = 31,100 LB.

TRIM CAS = 85 KNOTS
DENSITY ALTITUDE = 6300 FT.
RPM = 2605/186

LEVEL FLIGHT

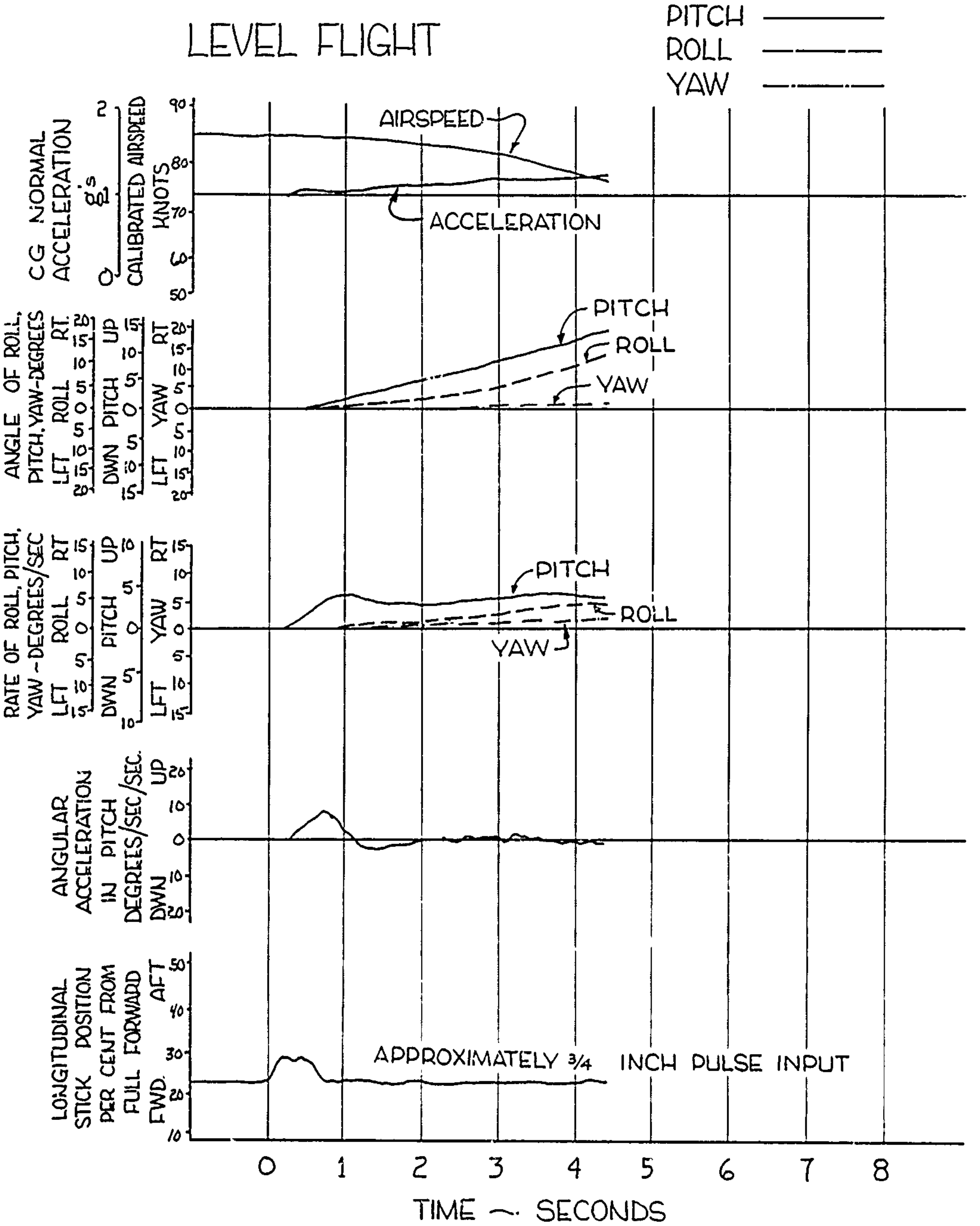


FIGURE NO. 19
RESPONSE TO A FWD. LONGITUDINAL PULSE-ASE ON
CH-37B, U.S.A., S/N 54-0998

FULL LONGITUDINAL TRAVEL = 16 INCHES
CG LOCATION = STATION 236.5 (MID)
AVG GROSS WEIGHT = 31,300 LB.

HOVER (IGE)

NOTE · TOTAL LONGITUDINAL INPUT IS LONG. STICK POSITION PLUS LONG. ASE POSITION.

TRIM CAS = 0 KNOTS
DENSITY ALTITUDE = 2100 FT.
RPM = 2720/194
PITCH ————
ROLL — — —
YAW —·—·—

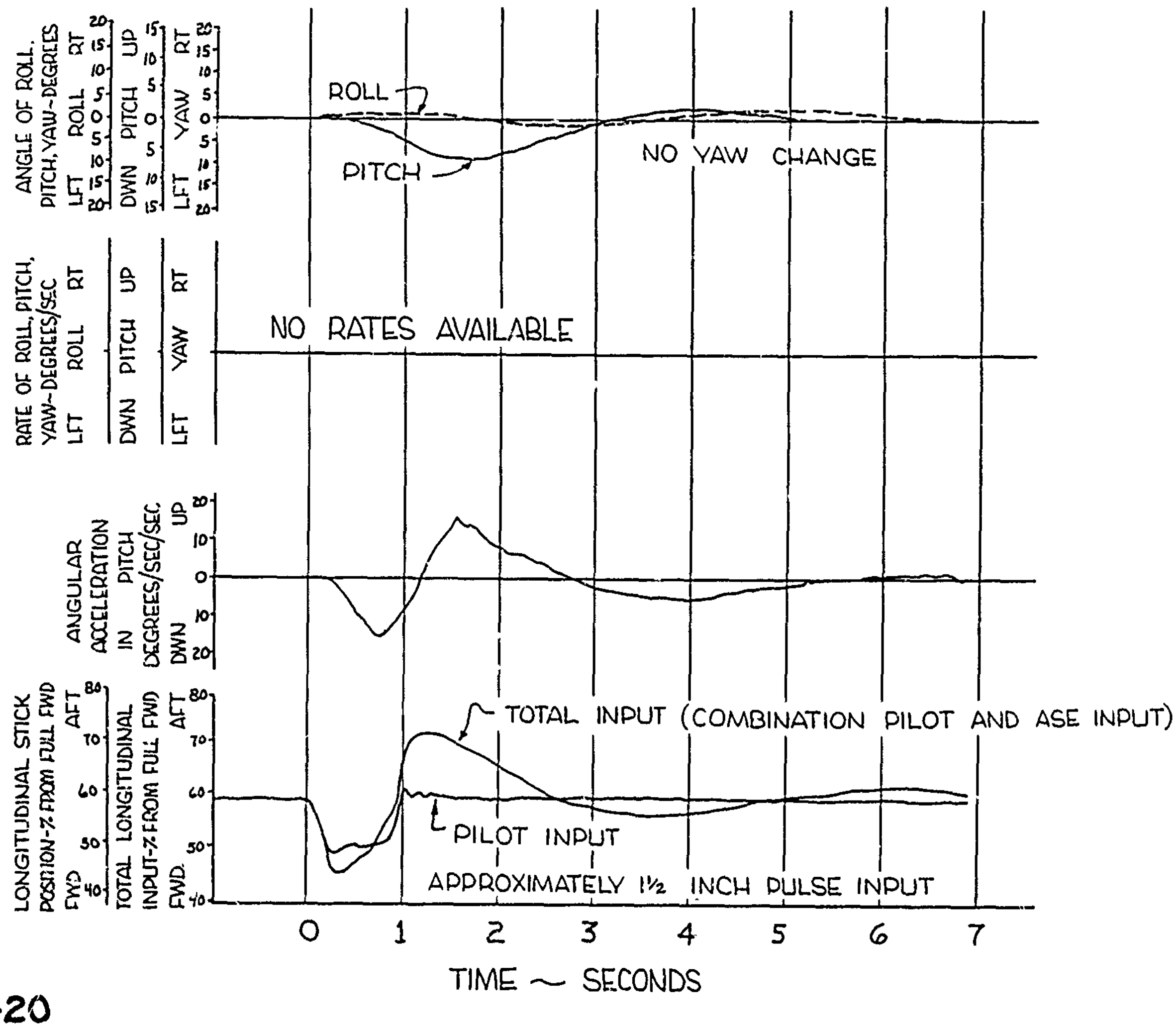


FIGURE NO. 20
RESPONSE TO A FWD. LONGITUDINAL PULSE~ASE ON CH-37B, U.S.A., S/N 54-0998

FULL LONGITUDINAL TRAVEL = 16 INCHES
C.G. LOCATION = STATION 242
AVG GROSS WEIGHT = 30,480 LB.

TRIM CAS = 46 KNOTS
DENSITY ALTITUDE = 6930 FT.
RPM = 2605/186

LEVEL FLIGHT

NOTE · TOTAL LONGITUDINAL INPUT IS LONG STICK POSITION PLUS LONG ASE POSITION.

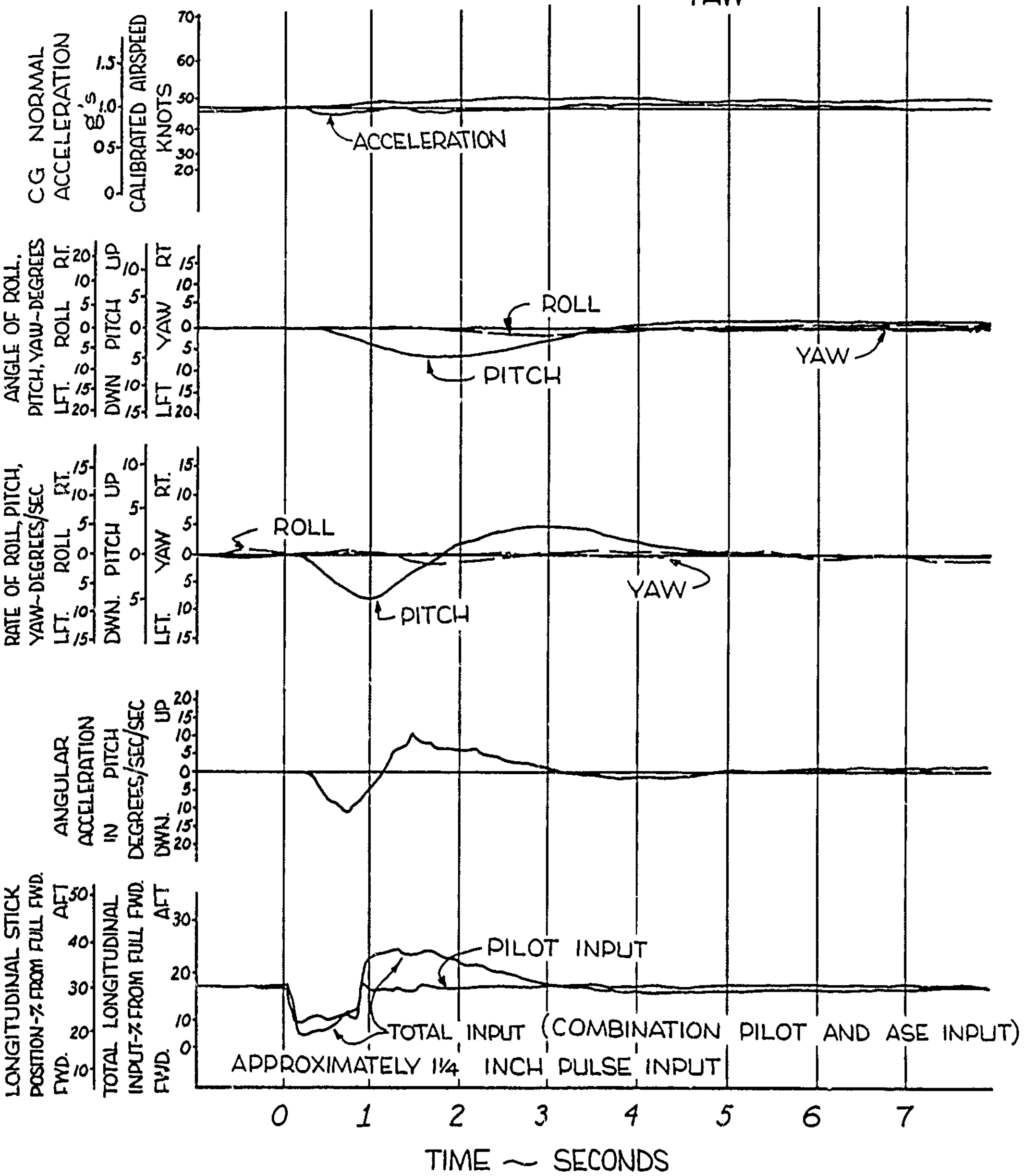


FIGURE NO. 21
RESPONSE TO AN AFT LONGITUDINAL PULSE~ASE ON
CH-37B, U.S.A., S/N 54-0998

FULL LONGITUDINAL TRAVEL = 16 INCHES
C G LOCATION = STATION 242
AVG GROSS WEIGHT = 30,580 LB.

TRIM CAS = 45 KNOTS
DENSITY ALTITUDE = 6680 FT.
RPM = 2605/186

LEVEL FLIGHT

NOTE · TOTAL LONGITUDINAL INPUT IS LONG STICK POSITION PLUS LONG ASE POSITION.

PITCH ————
ROLL — — —
YAW —·—·—

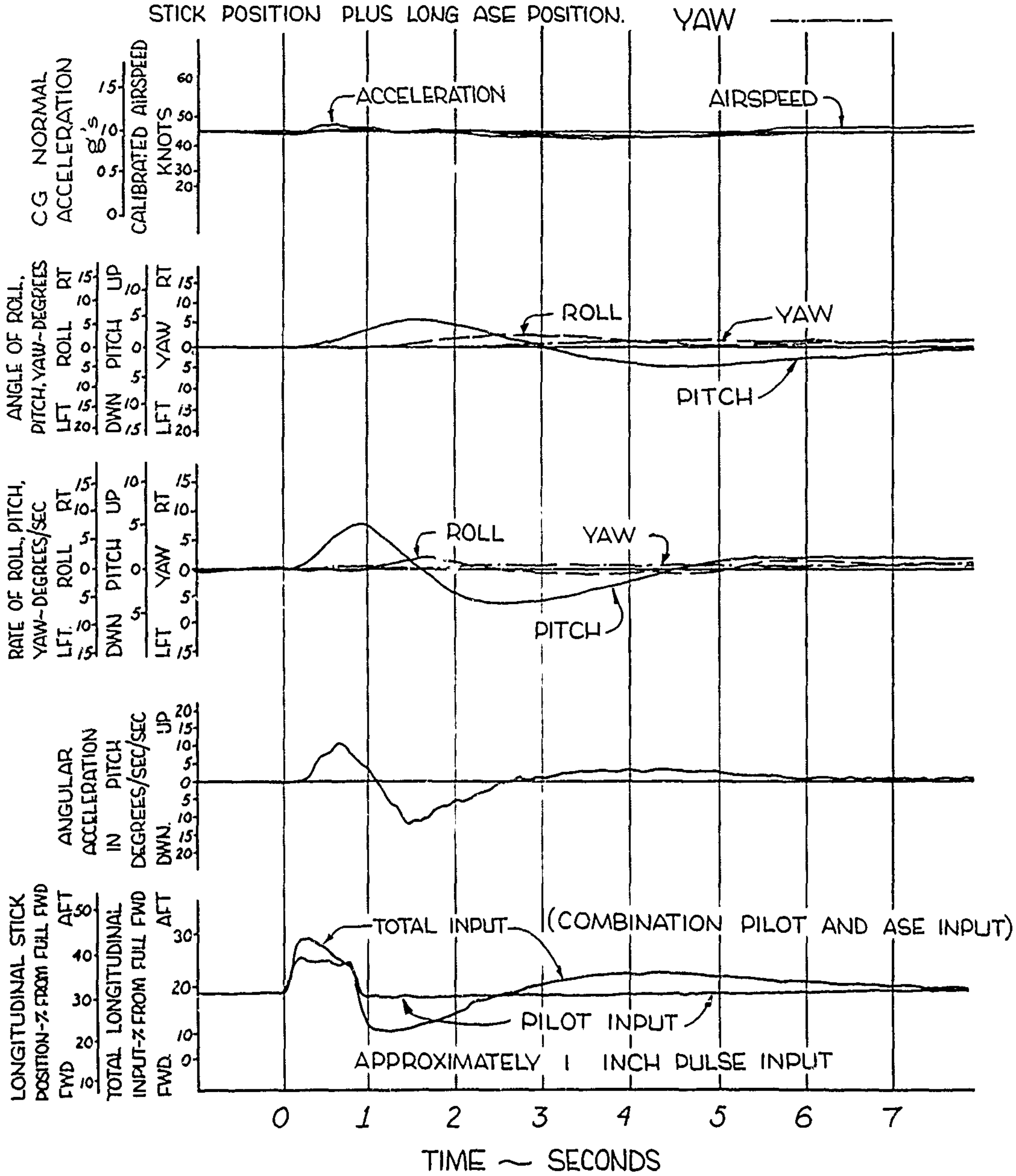


FIGURE NO. 22
RESPONSE TO A FWD. LONGITUDINAL PULSE~ASE ON
CH-37B, U.S.A., S/N 54-0998

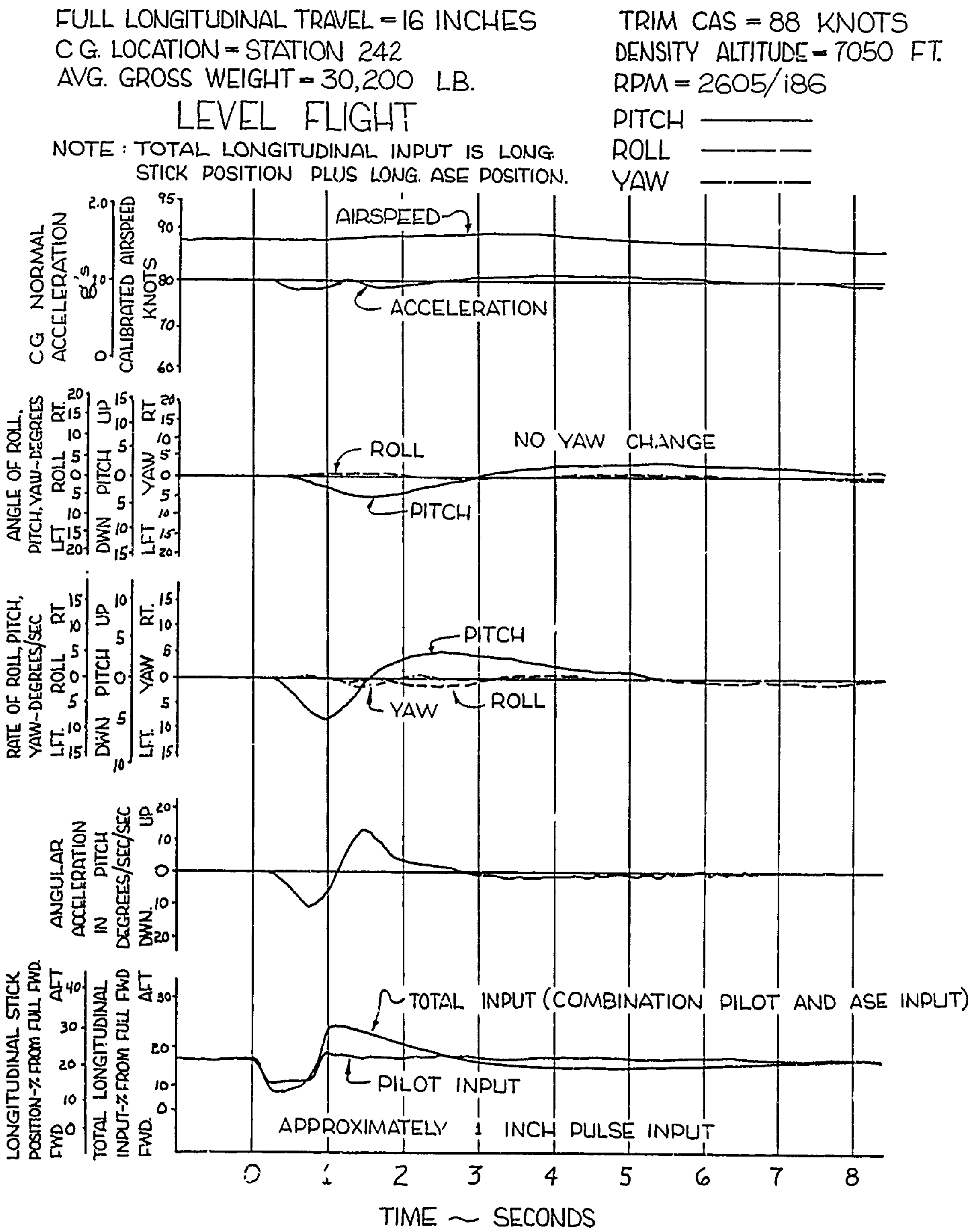


FIGURE NO. 23
RESPONSE TO A LEFT LATERAL PULSE ~ASE OFF
CH-37B, U.S.A., S/N 54-998

FULL LATERAL TRAVEL = 15 INCHES
C.G. LOCATION = STATION 242
AVG. GROSS WEIGHT = 30,920 LB.

TRIM CAS = 45 KNOTS
DENSITY ALTITUDE = 6340 FT.
RPM = 2605/186

LEVEL FLIGHT

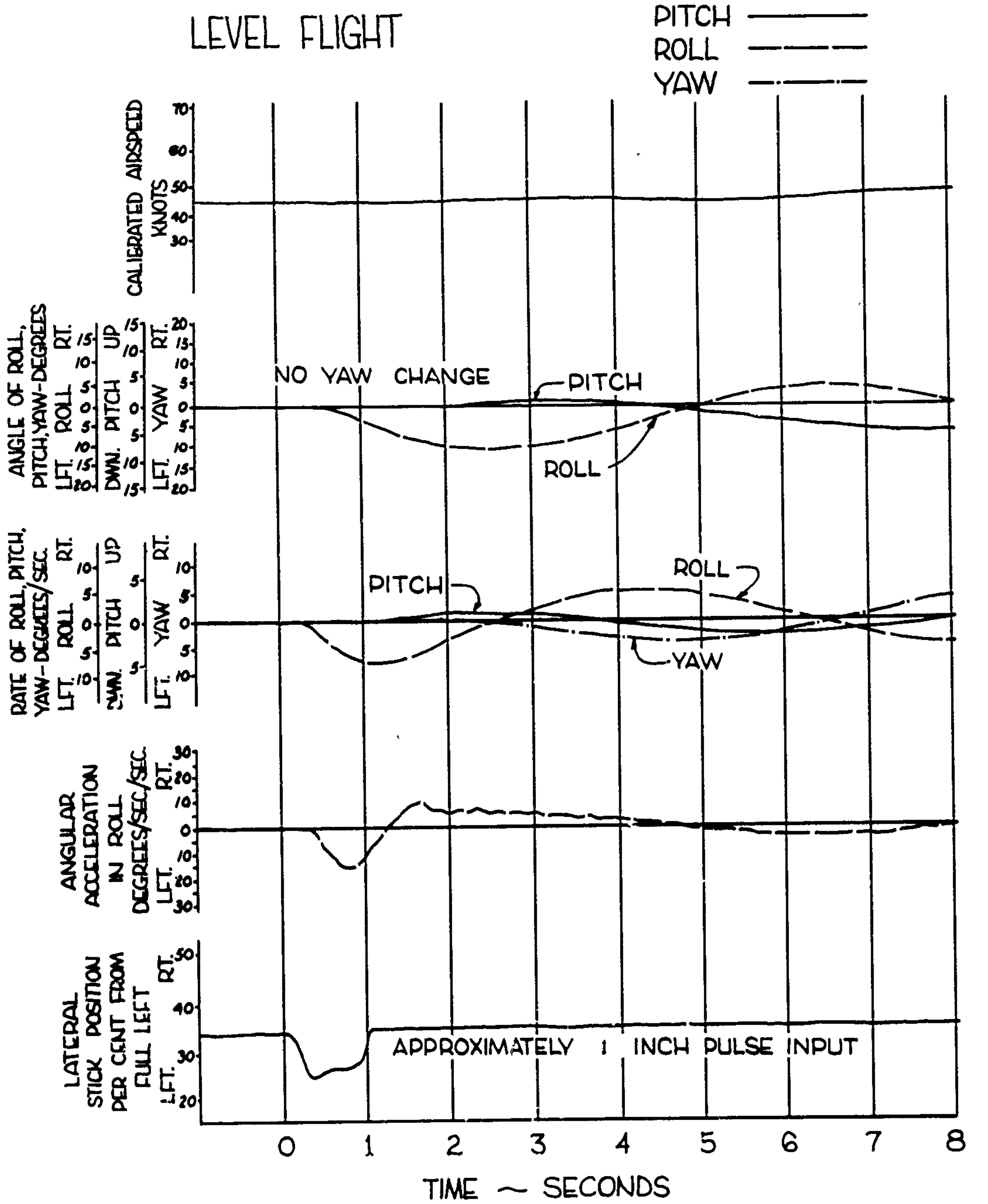


FIGURE NO.24
RESPONSE TO A LEFT LATERAL PULSE ~ ASE OFF
CH-37B, U.S.A., S/N 54-998

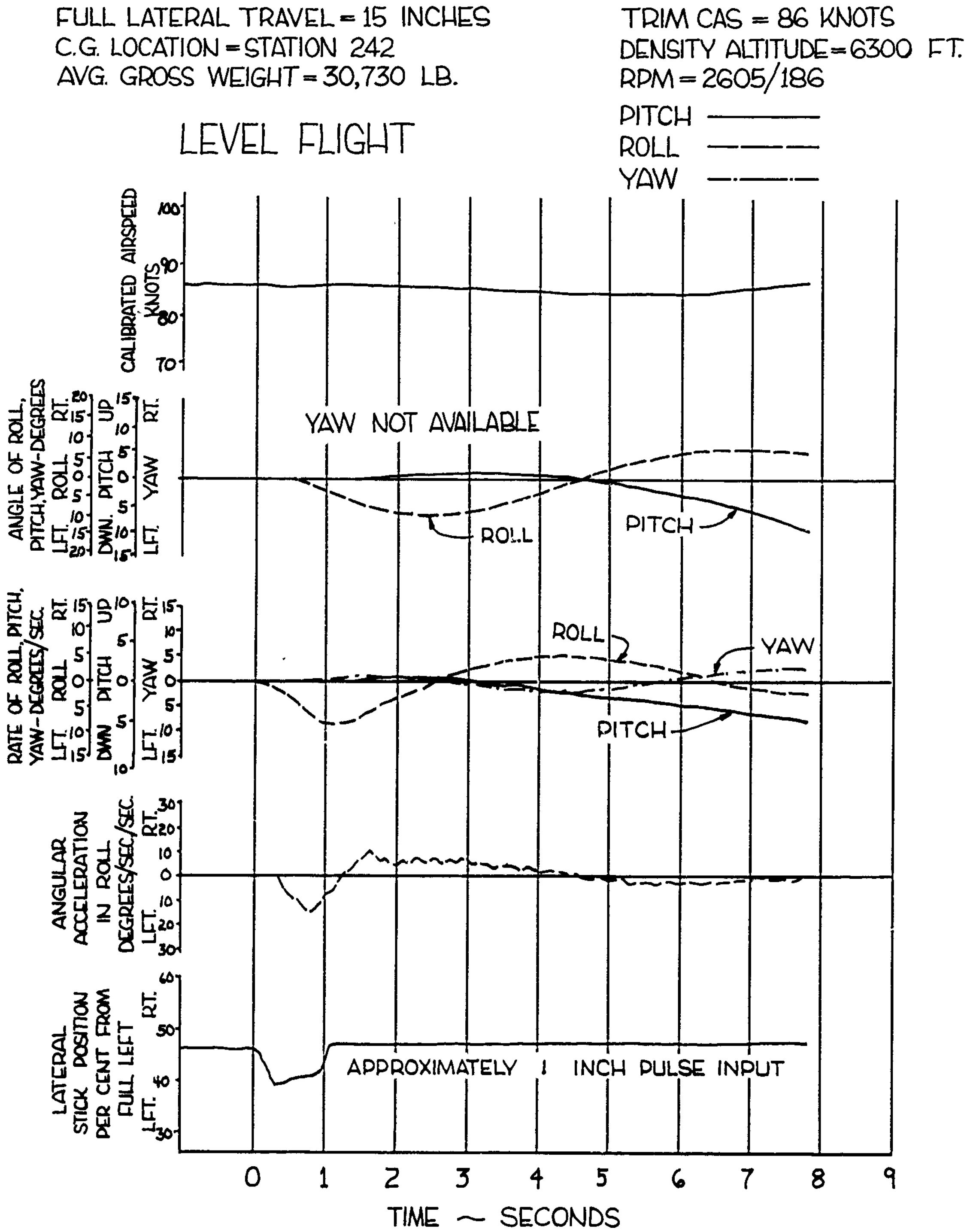


FIGURE NO. 25
RESPONSE TO A LEFT LATERAL PULSE ~ ASE ON
CH-37B, U.S.A., S/N 54-0998

FULL LATERAL TRAVEL = 15 INCHES
C.G. LOCATION = STATION 236.5 (MID)
AVG. GROSS WEIGHT = 30,500 LB.
HOVER (IGE)
NOTE: TOTAL LATERAL INPUT IS LATERAL STICK POSITION PLUS LAT. ASE POSITION.

TRIM CAS = 0 KNOTS
DENSITY ALTITUDE = 2100 FT.
RPM = 2730/195
PITCH ————
ROLL — — —
YAW — - — -

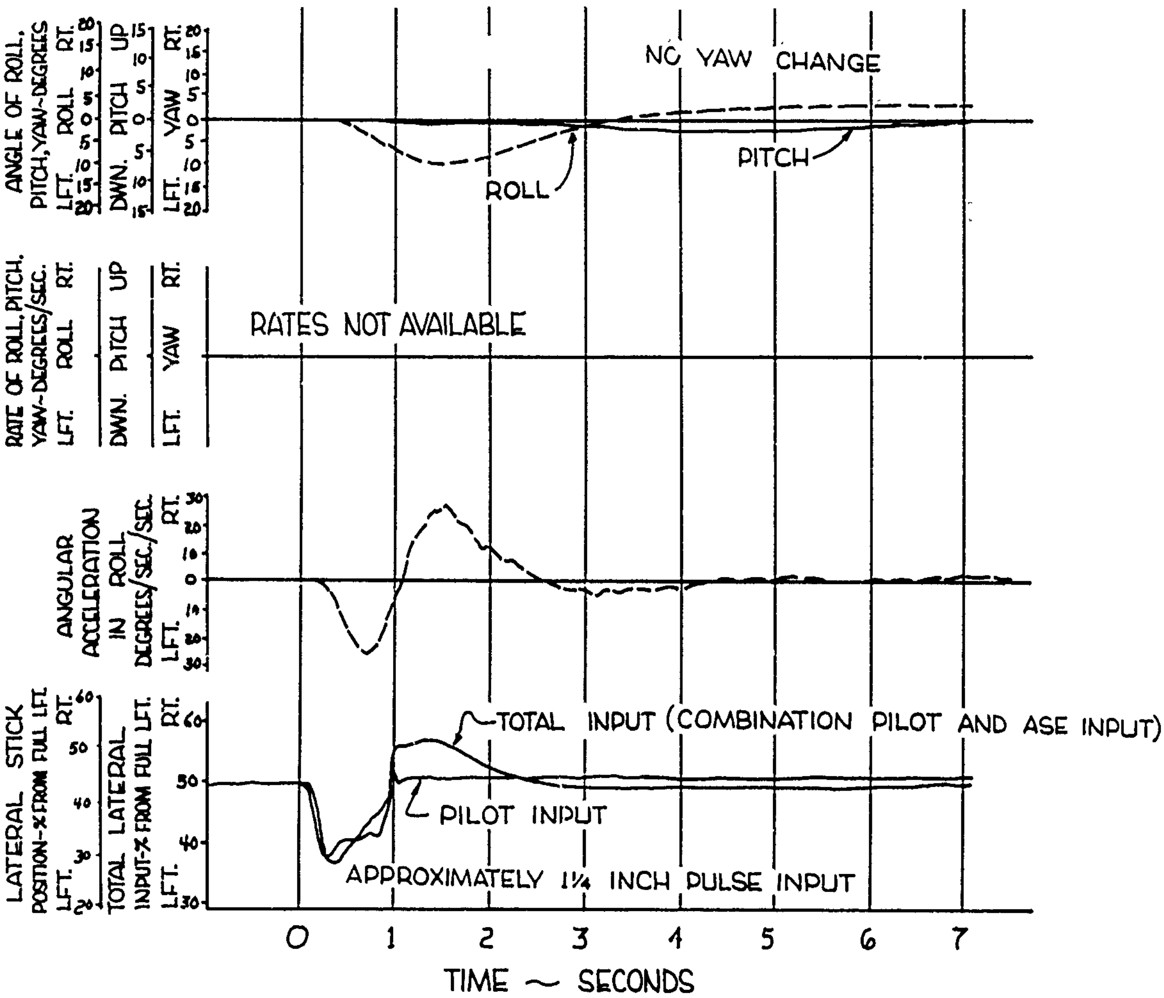


FIGURE NO.26
RESPONSE TO A LEFT LATERAL PULSE~ASE ON
CH-37B, U.S.A., S/N 54-0998

FULL LATERAL TRAVEL = 15 INCHES
C.G. LOCATION = STATION 242
AVG. GROSS WEIGHT = 30,350 LB.

TRIM CAS = 44 KNOTS
DENSITY ALTITUDE = 7200 FT.
RPM = 2605/186

LEVEL FLIGHT

NOTE: TOTAL LATERAL INPUT IS LATERAL STICK POSITION PLUS LAT. ASE POSITION.

PITCH ———
ROLL — — —
YAW —·—·—

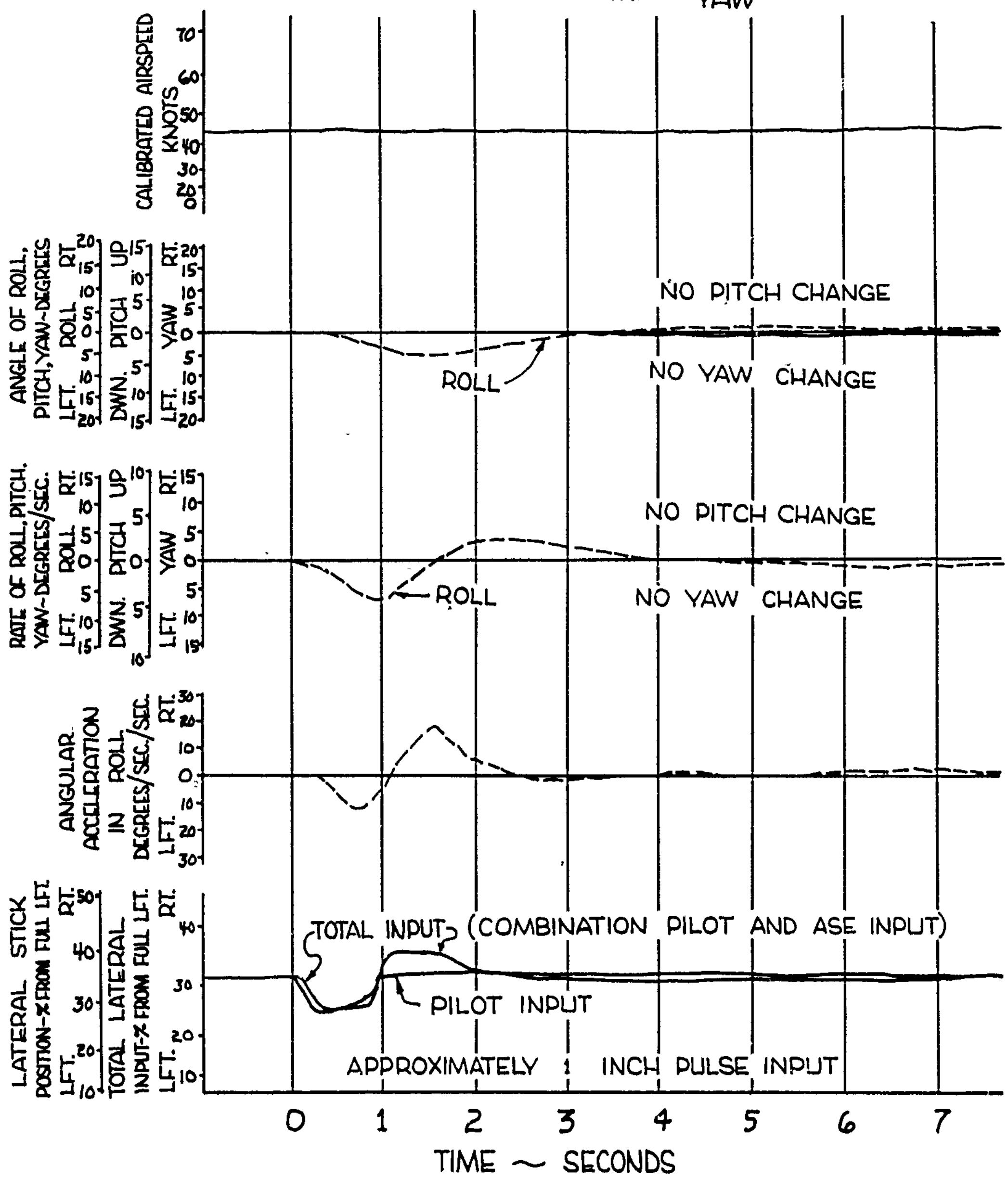


FIGURE NO.27
RESPONSE TO A LEFT LATERAL PULSE~ ASE ON
CH-37B, U.S.A., S/N 54-0998

FULL LATERAL TRAVEL = 15 INCHES
C.G. LOCATION = STATION 242
AVG. GROSS WEIGHT = 30,040 LB.

TRIM CAS = 86 KNOTS
DENSITY ALTITUDE = 6560 FT.
RPM = 2605/186

LEVEL FLIGHT

NOTE: TOTAL LATERAL INPUT IS LATERAL STICK POSITION PLUS LAT. ASE POSITION.

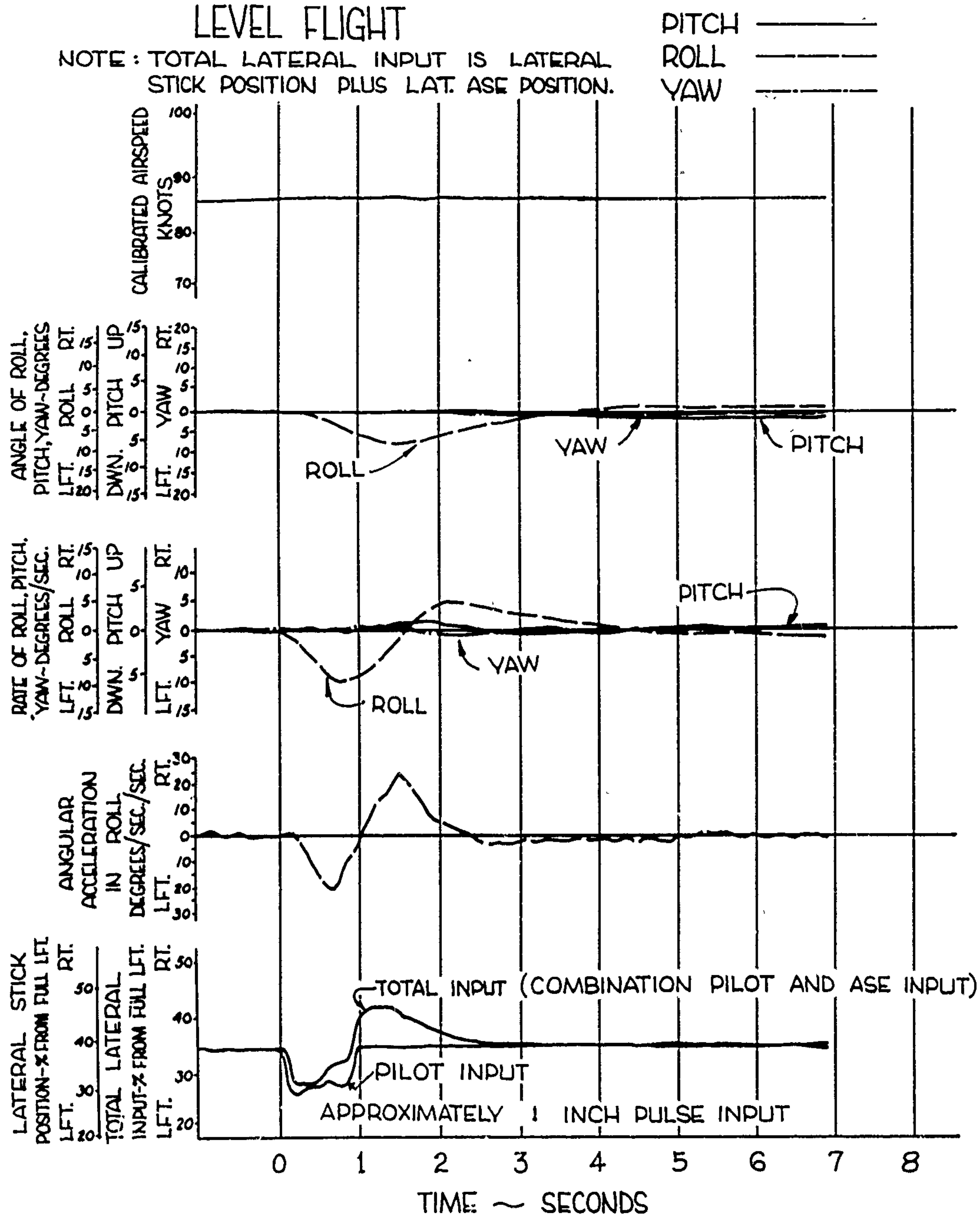


FIGURE NO. 28
RESPONSE TO A LEFT DIRECTIONAL PULSE - ASE OFF
CH-37B, U.S.A., S/N 54-0998

FULL PEDAL TRAVEL = 3.8 INCHES
C.G. LOCATION = STATION 242
AVG. GROSS WEIGHT = 30,700 LB.

TRIM CAS = 44 KNOTS
DENSITY ALTITUDE = 6680 FT.
RPM = 2605/186

LEVEL FLIGHT

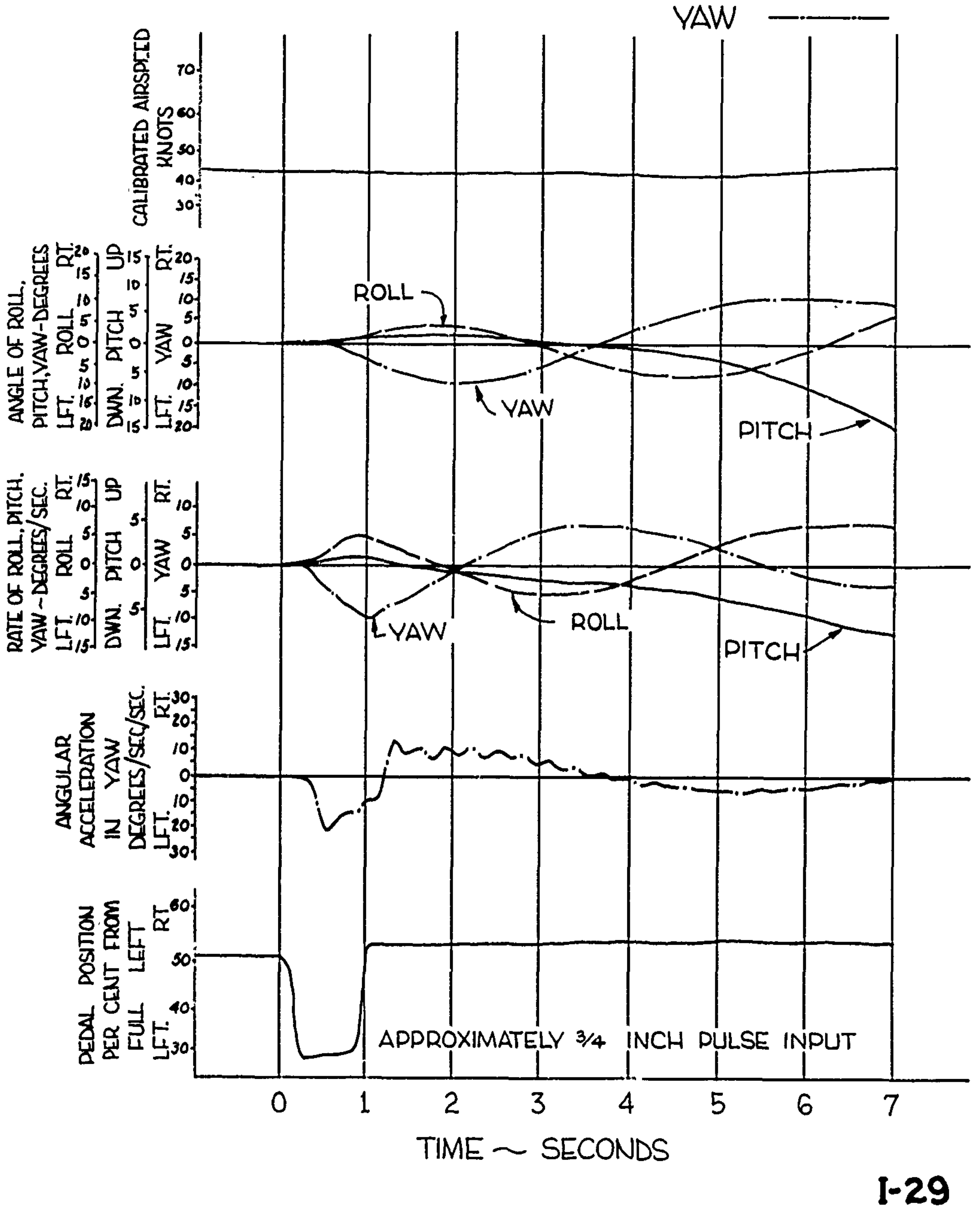


FIGURE NO. 29
RESPONSE TO A RIGHT DIRECTIONAL PULSE - ASE OFF
CH-37B, U.S.A., S/N 54-0998

FULL PEDAL TRAVEL = 3.8 INCHES
C.G. LOCATION = STATION 242
AVG. GROSS WEIGHT = 30,800 LB.

TRIM CAS = 45 KNOTS
DENSITY ALTITUDE = 6680 FT.
RPM = 2605/186

LEVEL FLIGHT

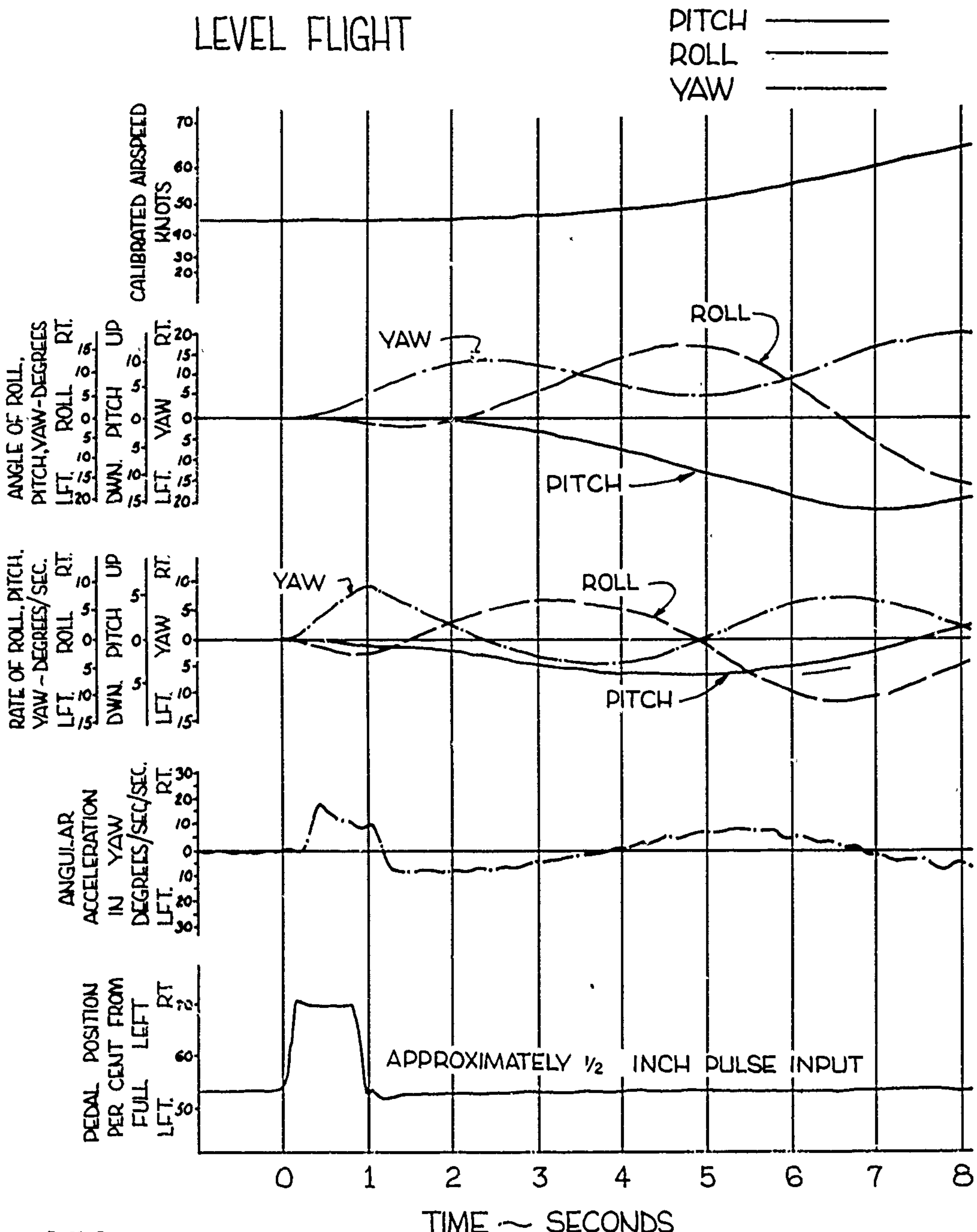


FIGURE NO. 30
RESPONSE TO A LEFT DIRECTIONAL PULSE-ASE OFF
CH-37B, U.S.A., S/N 54-0998

FULL PEDAL TRAVEL = 3.8 INCHES
C.G. LOCATION = STATION 242
AVG. GROSS WEIGHT = 30,450 LB.

TRIM CAS = 82.5 KNOTS
DENSITY ALTITUDE = 6100 FT.
RPM = 2605/186

LEVEL FLIGHT

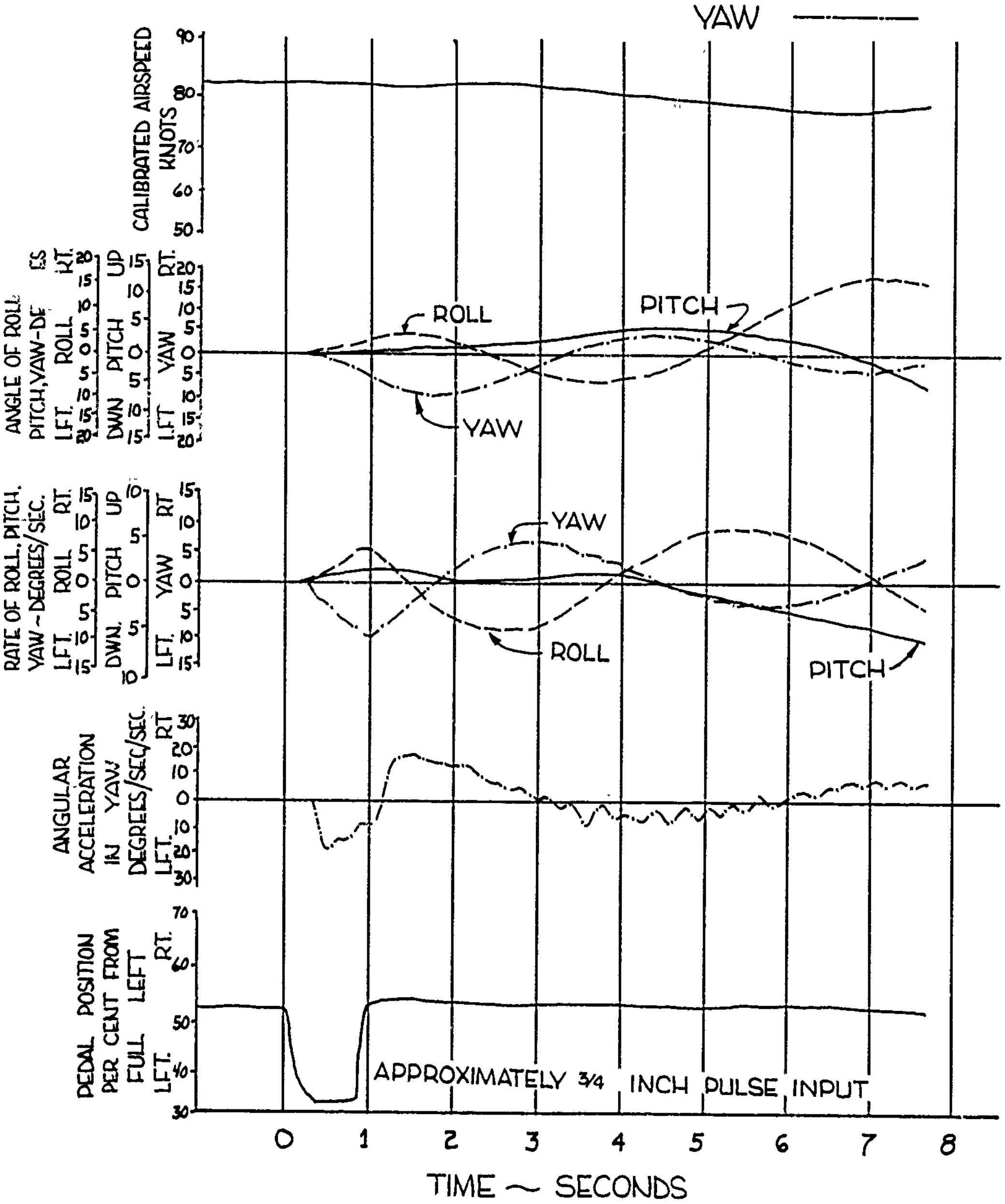


FIGURE NO.31
RESPONSE TO A LEFT DIRECTIONAL PULSE ~ ASE ON
CH-37B, U.S.A., S/N 54-0998

FULL PEDAL TRAVEL = 3.8 INCHES
C.G. LOCATION - STATION 236.5 (MID)
AVG. GROSS WEIGHT - 30,000 LB.

HOVER (IGE)

NOTE: TOTAL PEDAL INPUT IS PEDAL POSITION PLUS PEDAL ASE POSITION.

TRIM CAS - 0 KNOTS
DENSITY ALTITUDE - 2100 FT.
RPM - 2720/194

PITCH
ROLL
YAW

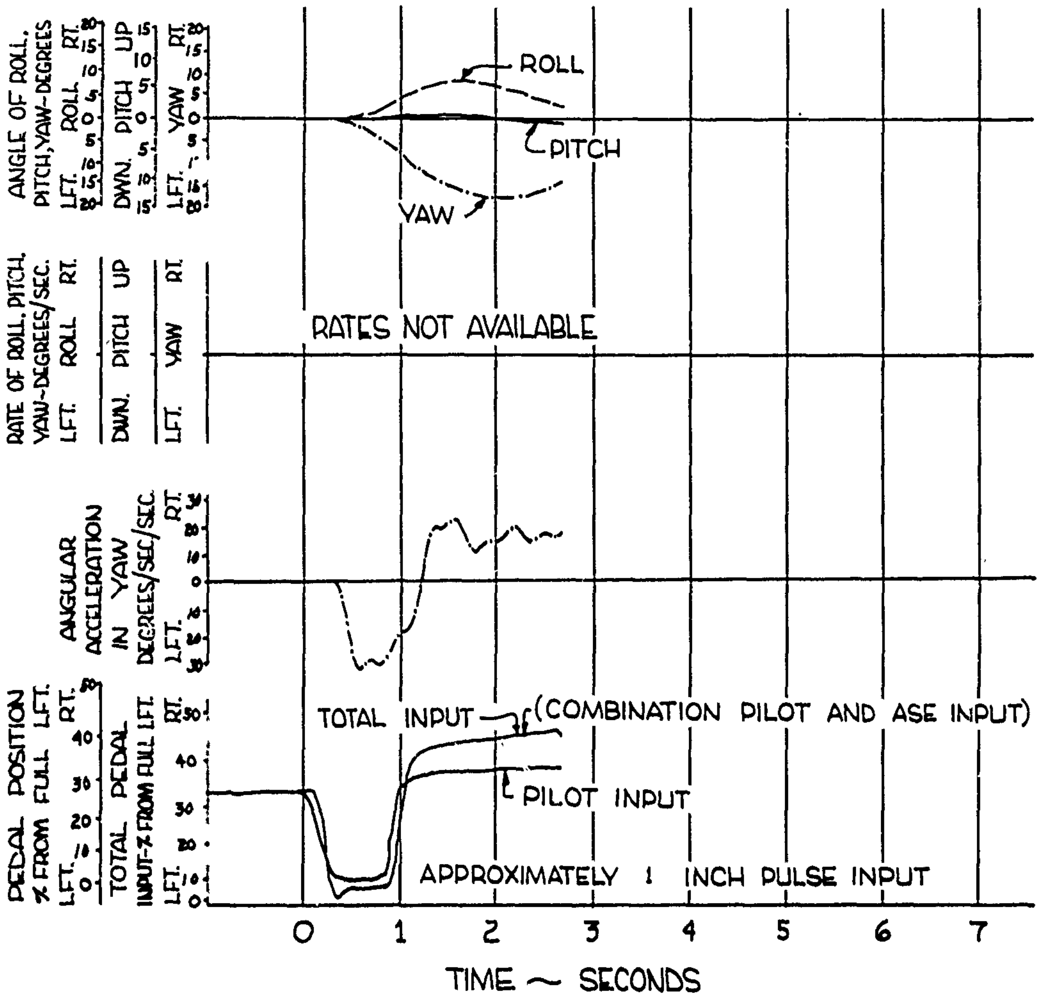


FIGURE NO.32
RESPONSE TO A LEFT DIRECTIONAL PULSE~ASE ON
CH-37B, U.S.A., S/N 54-0998

FULL PEDAL TRAVEL = 3.8 INCHES
C.G. LOCATION = STATION 242
AVG. GROSS WEIGHT = 30,150 LB.

TRIM CAS = 44 KNOTS
DENSITY ALTITUDE = 7450 FT.
RPM = 2605/186

LEVEL FLIGHT

NOTE: TOTAL PEDAL INPUT IS PEDAL POSITION PLUS PEDAL ASE POSITION.

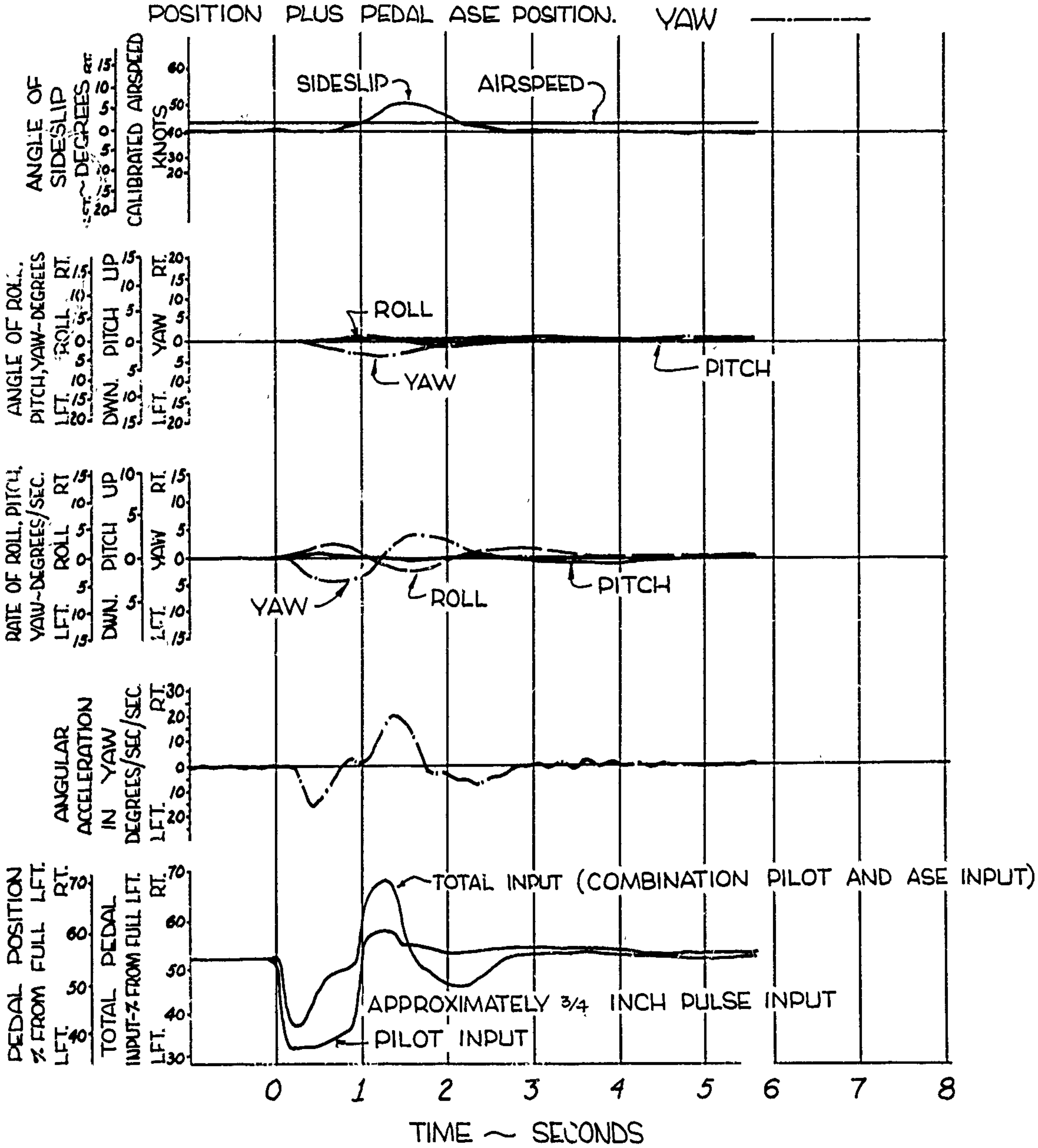


FIGURE NO.33
RESPONSE TO A RIGHT DIRECTIONAL PULSE ~ ASE ON
CH-37B, U.S.A., S/N 54-0998

FULL PEDAL TRAVEL = 3.8 INCHES
C.G. LOCATION — STATION 242
AVG. GROSS WEIGHT — 29,980 LB.

TRIM CAS — 86 KNOTS
DENSITY ALTITUDE — 6820 FT.
RPM — 2605/186

LEVEL FLIGHT

NOTE: TOTAL PEDAL INPUT IS PEDAL POSITION PLUS PEDAL ASE POSITION.

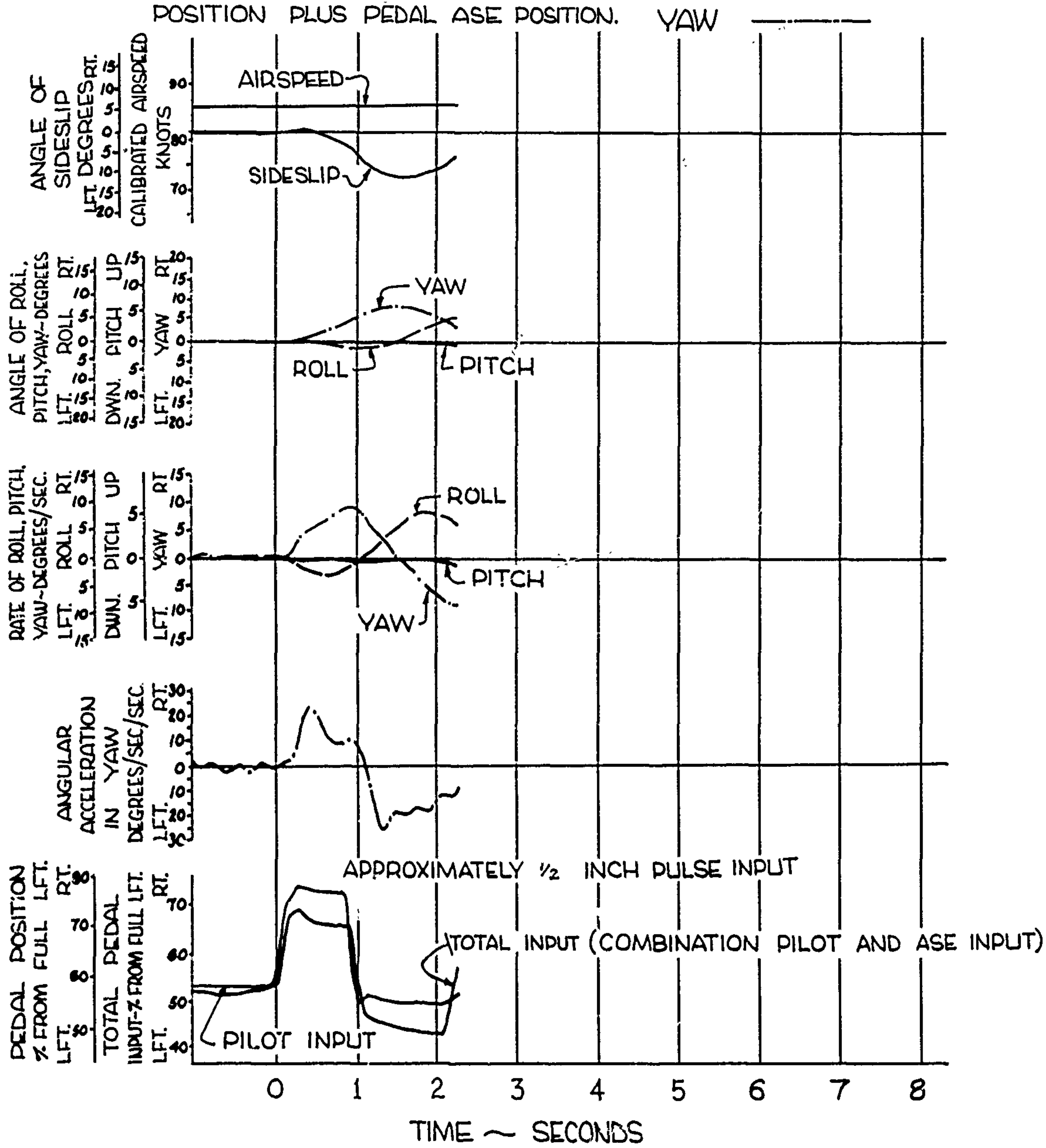


FIGURE NO. 34

LONGITUDINAL CONTROL SENSITIVITY

CH-37B, U.S.A., S/N 54-0998

SYMBOL	TRIM CALIBRATED AIRSPEED ~KNOTS	AVERAGE DENSITY ALTITUDE ~FEET	AVERAGE GROSS WEIGHT ~POUNDS	C.G. LOCATION (STATION)	RPM
○	HOVER (IGE)	1020	31,025	236.5 (MID)	2705/[illegible]
□	45	4200	30,850	242 (AFT)	2605/[illegible]
●	85	5810	30,925	242 (AFT)	2605/[illegible]

NOTE:
1. FULL LONGITUDINAL CONTROL TRAVEL = 16.0 INCHES
2. ONE INCH LONGITUDINAL TRAVEL = 6.25 PER CENT
3. APPROXIMATE TIME REQUIRED TO REACH MAXIMUM ACCELERATION = 0.67 SECONDS @ HOVER AND 45 KNOTS, AND 0.74 SECONDS @ 85 KNOTS
4. ALL CH-37A CURVES REF. AFFTC TR-60-15

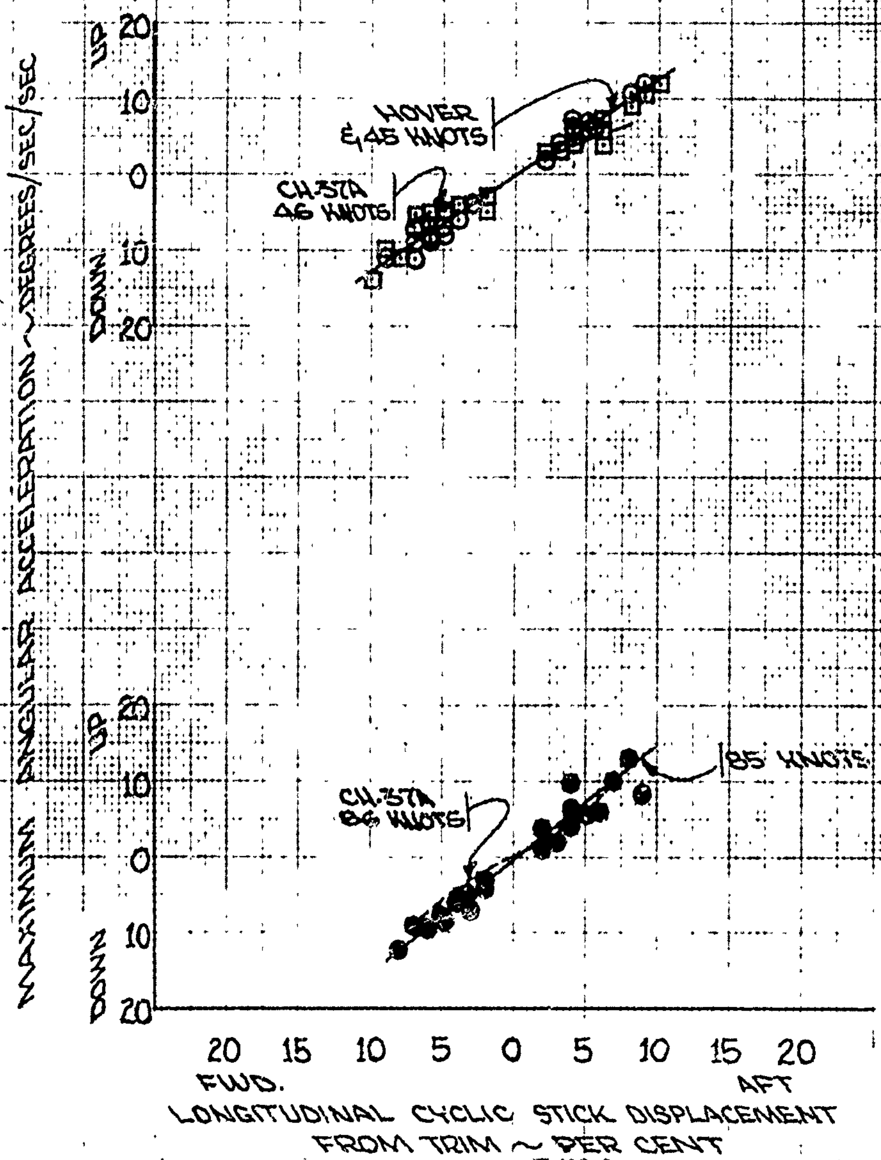


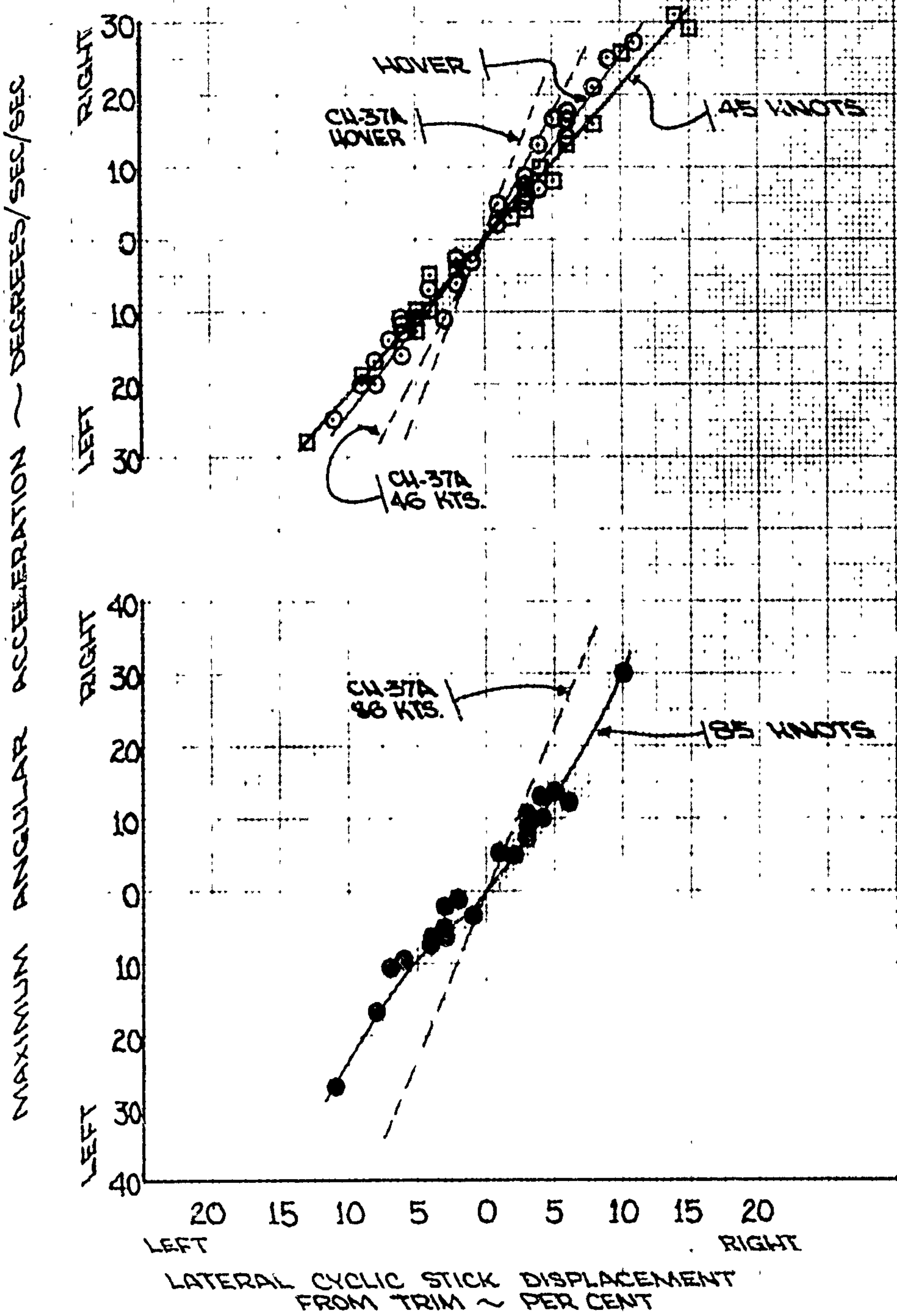
FIGURE NO. 35

LATERAL CONTROL SENSITIVITY

CH-37B, U.S.A., S/N 54-0998

SYMBOL	TRIM CALIBRATED AIRSPEED ~KNOTS	AVERAGE DENSITY ALTITUDE ~FEET	AVERAGE GROSS WEIGHT ~POUNDS	C.G. LOCATION (STATION)	RPM
○	HOVER (IGE)	525	30,650	235.5 (MID)	2680/192
□	45	5870	30,675	242 (AFT)	2605/186
●	85	5235	30,975	242 (AFT)	2605/186

NOTE:
1. FULL LATERAL CONTROL TRAVEL = 15.0 INCHES
2. ONE INCH LATERAL TRAVEL = 6.67 PER CENT
3. APPROXIMATE TIME REQUIRED TO REACH MAXIMUM ACCELERATION = 0.68 SECONDS
4. ALL CH-37A CURVES REF. AFFTC TR-60-15



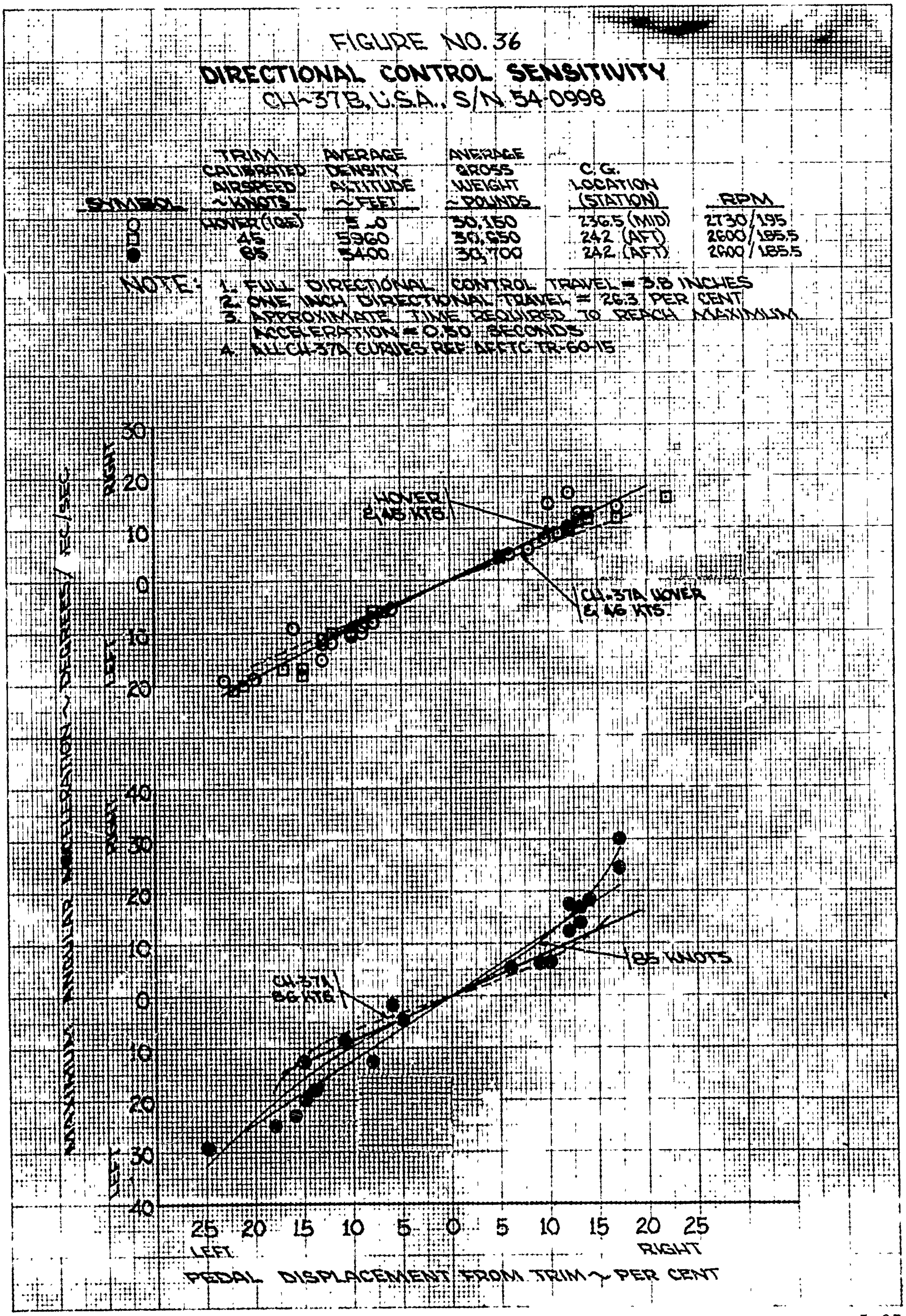


FIGURE NO. 36
DIRECTIONAL CONTROL SENSITIVITY
CH-37B, U.S.A., S/N 54-0998
SYMBOL
TRIM CALIBRATED AIRSPEED ~ KNOTS
AVERAGE DENSITY ALTITUDE ~ FEET
AVERAGE GROSS WEIGHT ~ POUNDS
C.G. LOCATION (STATION)
RPM
HOVER (IGE) 30,150 236.5 (MID) 2730/195
45 5960 30,650 242 (AFT) 2600/185.5
85 5400 30,700 242 (AFT) 2600/185.5
NOTE: 1. FULL DIRECTIONAL CONTROL TRAVEL = 3.8 INCHES
2. ONE INCH DIRECTIONAL TRAVEL = 26.3 PER CENT
3. APPROXIMATE TIME REQUIRED TO REACH MAXIMUM ACCELERATION = 0.30 SECONDS
4. ALL CH-37A CURVES REF AFFTC TR-60-15
HOVER & 45 KTS
CH-37A HOVER & 45 KTS
CH-37A 86 KTS
85 KNOTS
RIGHT
LEFT
PEDAL DISPLACEMENT FROM TRIM ~ PER CENT

FIGURE NO. 37

LONGITUDINAL CONTROL RESPONSE

CH-37B, U.S.A., S/N 54-998

SYMBOL	TRIM CALIBRATED AIRSPEED ~KNOTS	AVERAGE DENSITY ALTITUDE ~FEET	AVERAGE GROSS WEIGHT ~POUNDS	C.G. LOCATION (STATION)	RPM
○	HOVER (IGE)	1020	31,025	236.5 (MID)	2705/193
□	45	4200	30,850	242 (AFT)	2605/186
●	85	3810	30,925	242 (AFT)	2605/186

NOTE: 1. FULL LONGITUDINAL CONTROL TRAVEL = 16.0 INCHES
2. ONE INCH LONGITUDINAL TRAVEL = 6.25 PER CENT
3. APPROXIMATE TIME IN SECONDS REQUIRED TO REACH MAXIMUM RESPONSE

	HOVER	45 KNOTS	85 KNOTS
ASE ON	1.3	1.2	1.1
ASE OFF	2.8	2.3	2.5

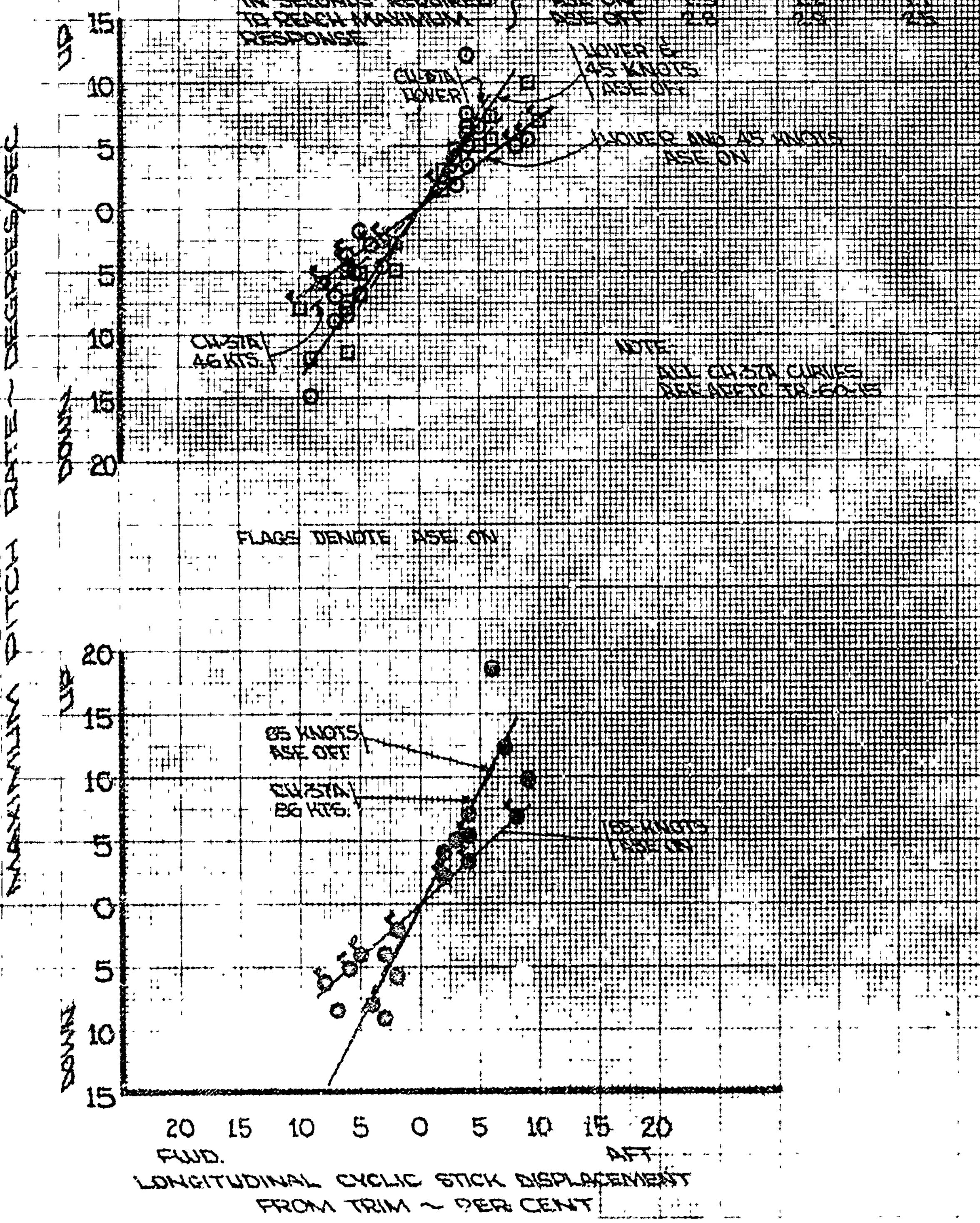


FIGURE NO. 38

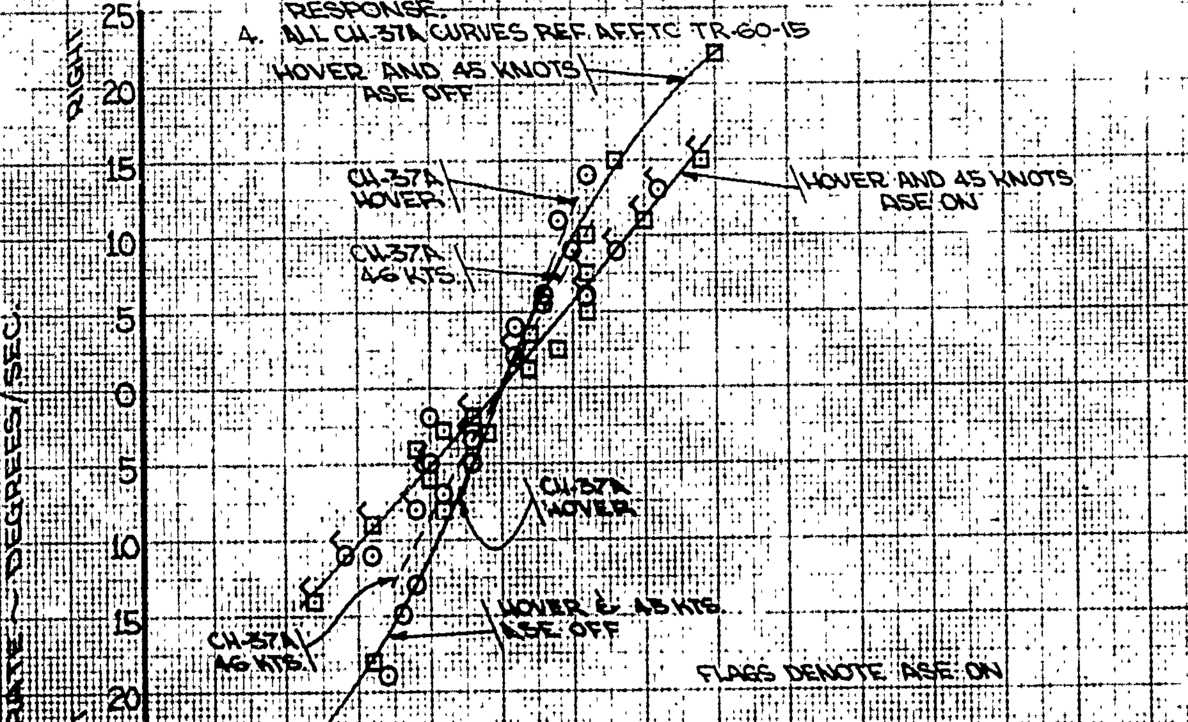
LATERAL CONTROL RESPONSE

CH-37B, U.S.A., S/N 54-0998

SYMBOL	TRIM CALIBRATED AIRSPEED ~KNOTS	AVERAGE DENSITY ALTITUDE ~FEET	AVERAGE GROSS WEIGHT ~POUNDS	C.G. LOCATION (STATION)	RPM
○	HOVER (IGE)	525	30,650	235.6 (MID)	2680/192
□	45	5870	30,675	242 (AFT)	2805/186
○	85	6235	30,975	242 (AFT)	2605/186

NOTE: 1. FULL LATERAL CONTROL TRAVEL = 15.0 INCHES
2. ONE INCH LATERAL TRAVEL = 6.67 PER CENT
3. APPROXIMATE TIME IN SECONDS REQUIRED TO REACH MAXIMUM RESPONSE

		HOVER	45 KNOTS	85 KNOTS
	ASE ON	1.1	1.1	1.0
	ASE OFF	2.0	2.0	2.2



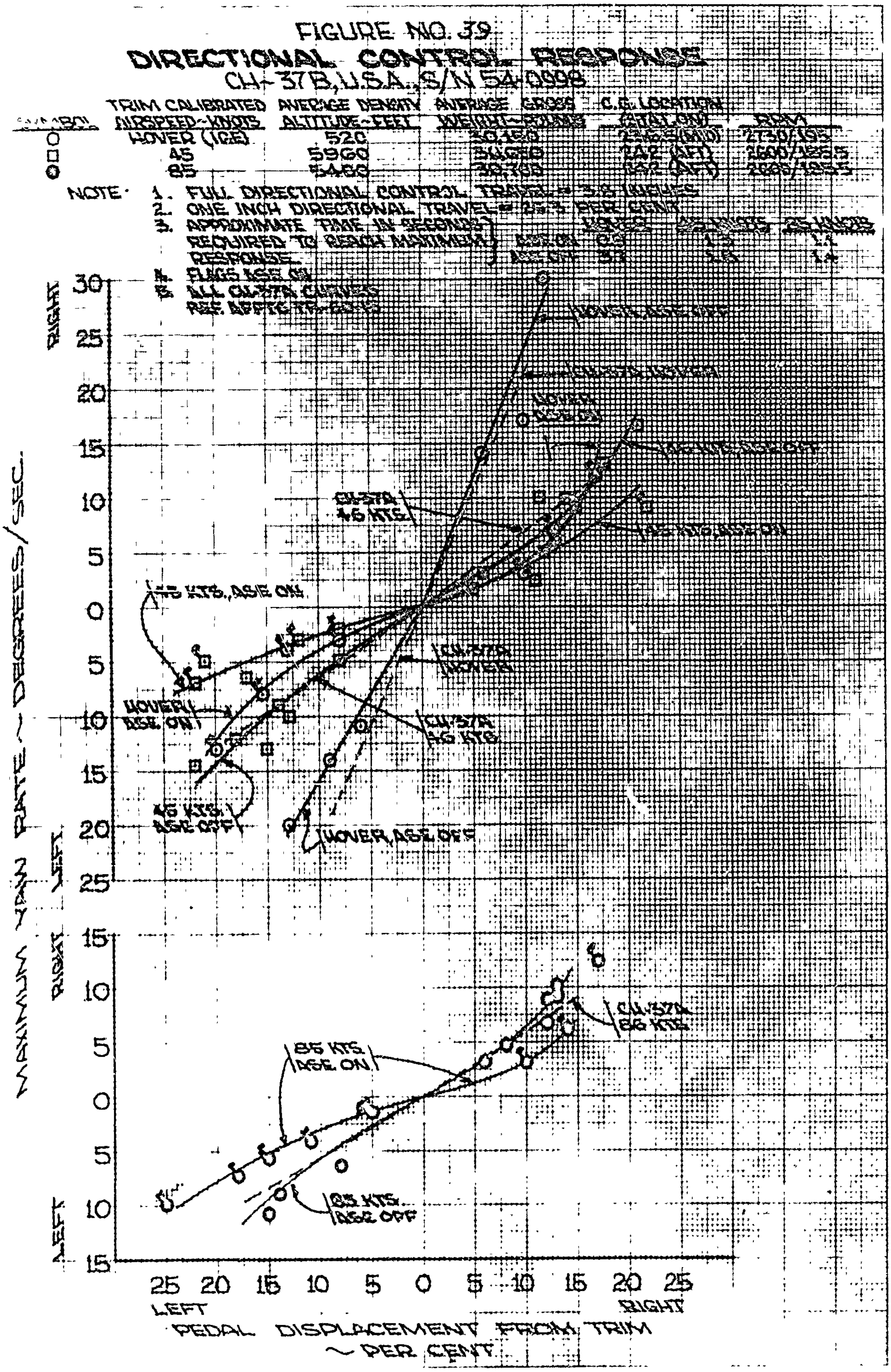


FIGURE NO. 39
DIRECTIONAL CONTROL RESPONSE
CH-37B, U.S.A., S/N 54-0998
SYMBOL | TRIM CALIBRATED AIRSPEED~KNOTS | AVERAGE DENSITY ALTITUDE~FEET | AVERAGE GROSS WEIGHT~POUNDS | C.G. LOCATION (STATION) | RPM
○ HOVER (IGE) 520
□ 45 5960
◉ 85 5460
NOTE: 1. FULL DIRECTIONAL CONTROL TRAVEL
2. ONE INCH DIRECTIONAL TRAVEL
3. APPROXIMATE TIME IN SECONDS REQUIRED TO REACH MAXIMUM RESPONSE
4. FLAGS ASE ON
5. ALL CH-37A CURVES
HOVER, ASE OFF
CH-37A HOVER
45 KTS. ASE OFF
CH-37A 45 KTS.
45 KTS. ASE ON
HOVER ASE ON
CH-37A HOVER
HOVER, ASE OFF
CH-37A 85 KTS.
85 KTS. ASE ON
85 KTS. ASE OFF
RIGHT
LEFT
MAXIMUM YAW RATE ~ DEGREES/SEC.
30
25
20
15
10
5
0
25 20 15 10 5 0 5 10 15 20 25
LEFT
RIGHT
PEDAL DISPLACEMENT FROM TRIM ~ PER CENT

FIGURE NO.40
RESPONSE TO A FWD. LONGITUDINAL STEP—ASE OFF
CH-37B, U.S.A., S/N 54-0998

FULL LONGITUDINAL TRAVEL = 16 INCHES
C.G. LOCATION = STATION 236.5 (MID)
AVG. GROSS WEIGHT = 30,900 LB.

TRIM CAS = 0 KNOTS
DENSITY ALTITUDE = 950 FT.
RPM = 2720/194

HOVER (IGE)

PITCH ————
ROLL — — —
YAW —·—·—

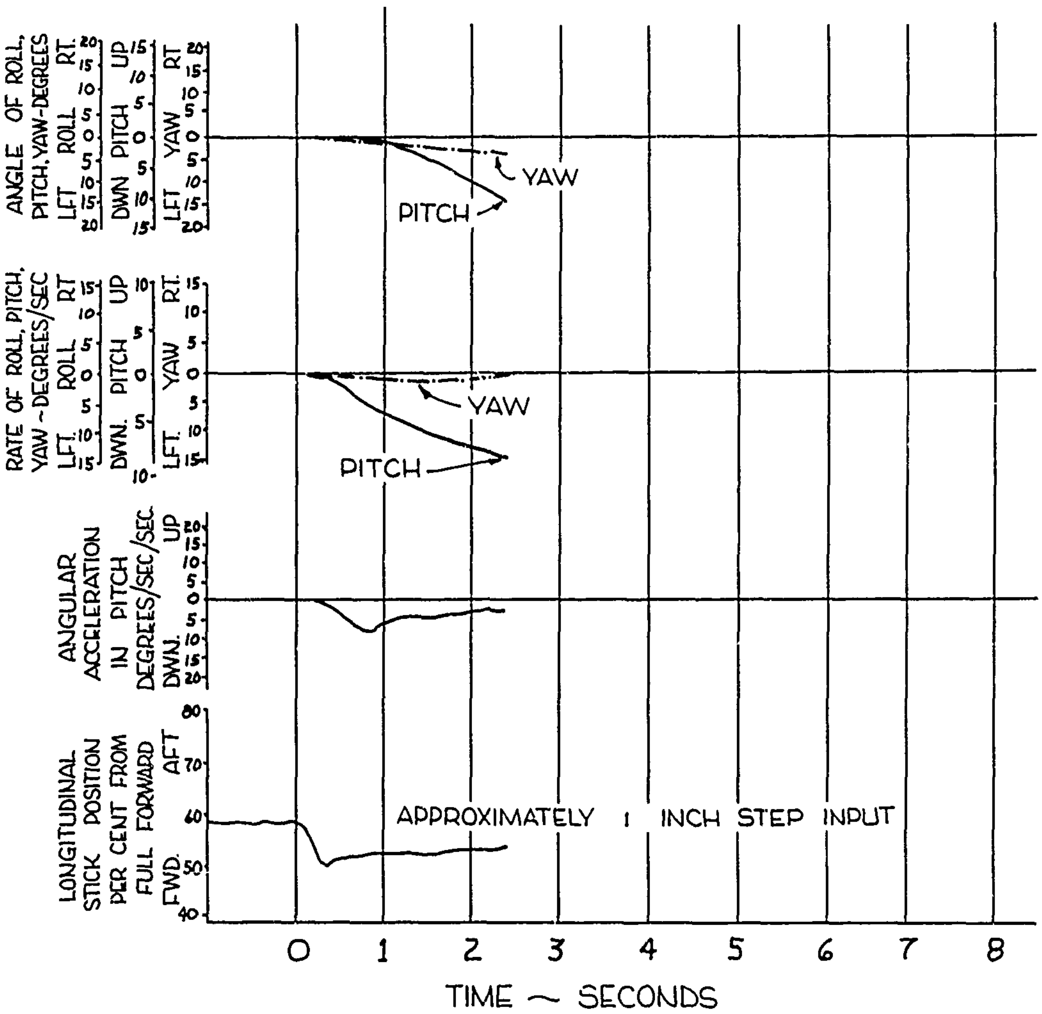


FIGURE NO.41
RESPONSE TO AN AFT LONGITUDINAL STEP -ASE OFF
CH-37B. U.S.A., S/N 54-0998

FULL LONGITUDINAL TRAVEL = 16 INCHES
C.G. LOCATION = STATION 242
AVG. GROSS WEIGHT = 31,130 LB.

TRIM CAS = 42 KNOTS
DENSITY ALTITUDE = 5960 FT.
RPM = 2605/186

LEVEL FLIGHT

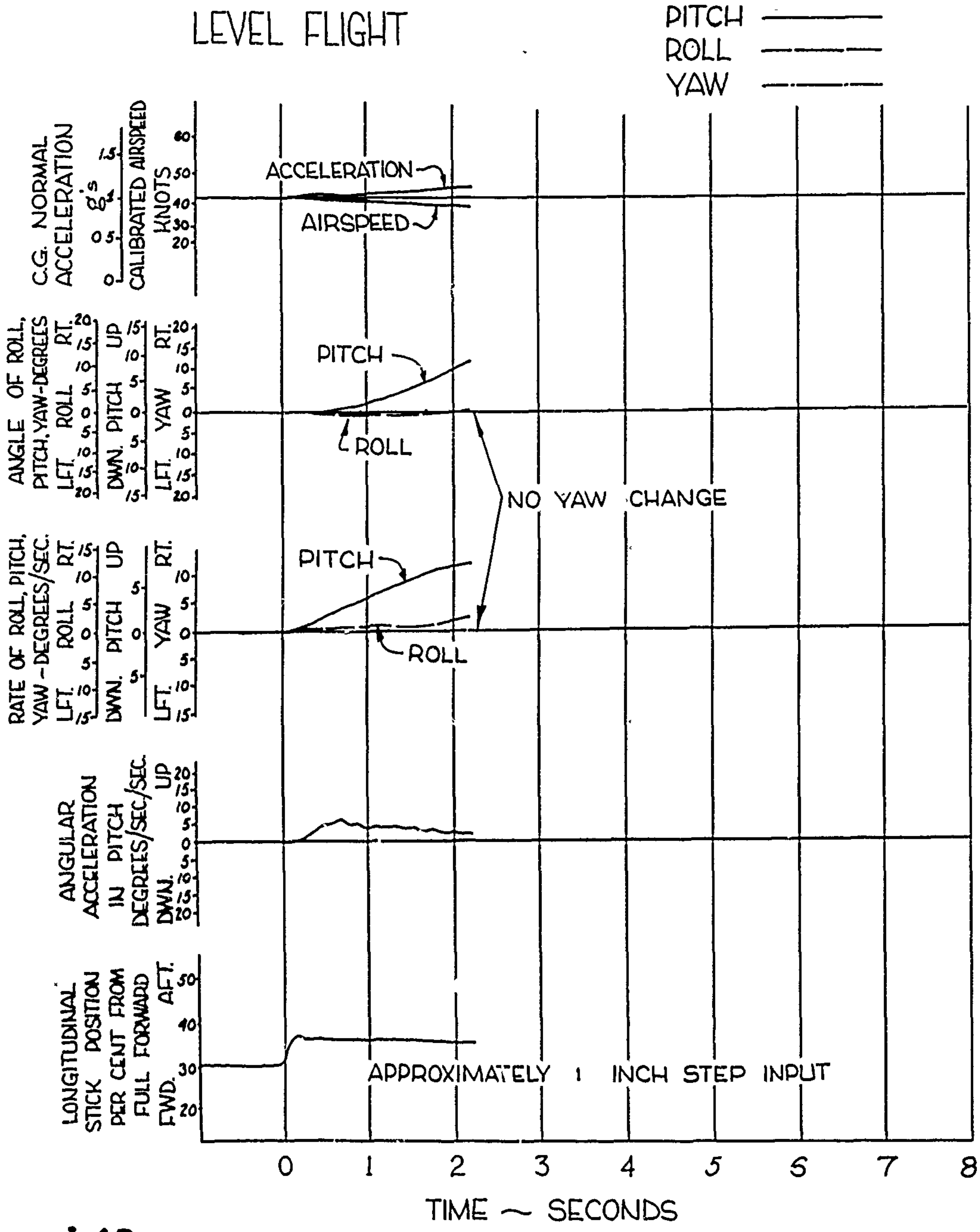


FIGURE NO.42
RESPONSE TO A FWD. LONGITUDINAL STEP—ASE OFF
CH-37B, U.S.A., S/N 54-0998

FULL LONGITUDINAL TRAVEL = 16 INCHES
C.G. LOCATION = STATION 242
AVG. GROSS WEIGHT = 30,900 LB.

TRIM CAS = 84 KNOTS
DENSITY ALTITUDE = 6100 FT.
RPM = 2605/186

LEVEL FLIGHT

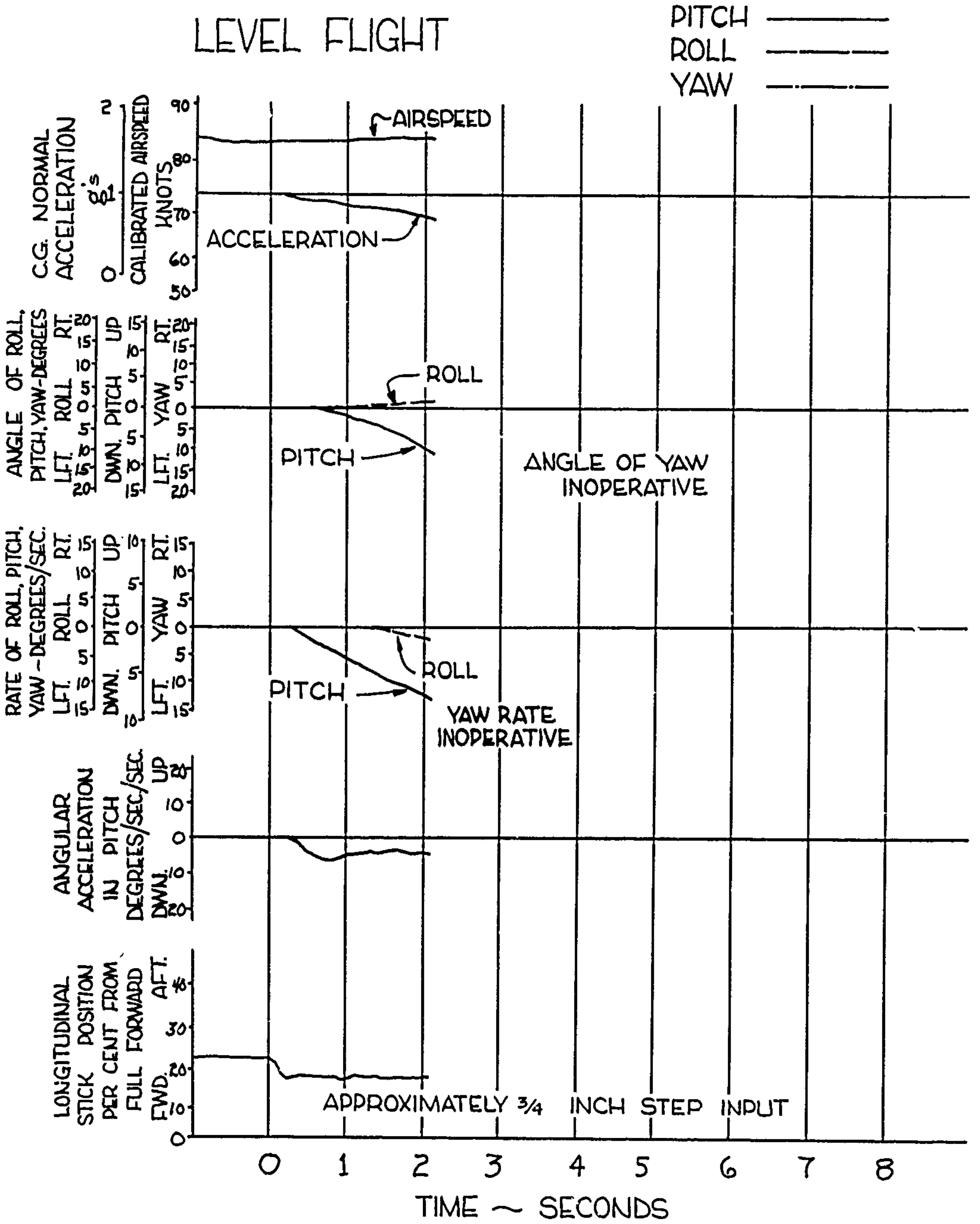


FIGURE NO.43
RESPONSE TO A FWD. LONGITUDINAL STEP~ASE ON
CH-37B, U.S.A., S/N 54-0998

FULL LONGITUDINAL TRAVEL = 16 INCHES
C.G. LOCATION = STATION 236.5 (MID)
AVG. GROSS WEIGHT = 30,700 LB.
HOVER IGE

NOTE: TOTAL LONGITUDINAL INPUT IS LONG. STICK POSITION PLUS LONG. ASE POSITION.

TRIM CAS = 0 KNOTS
DENSITY ALTITUDE = 2100 FT.
RPM = 2720/194
PITCH ————
ROLL — — —
YAW —·—·—

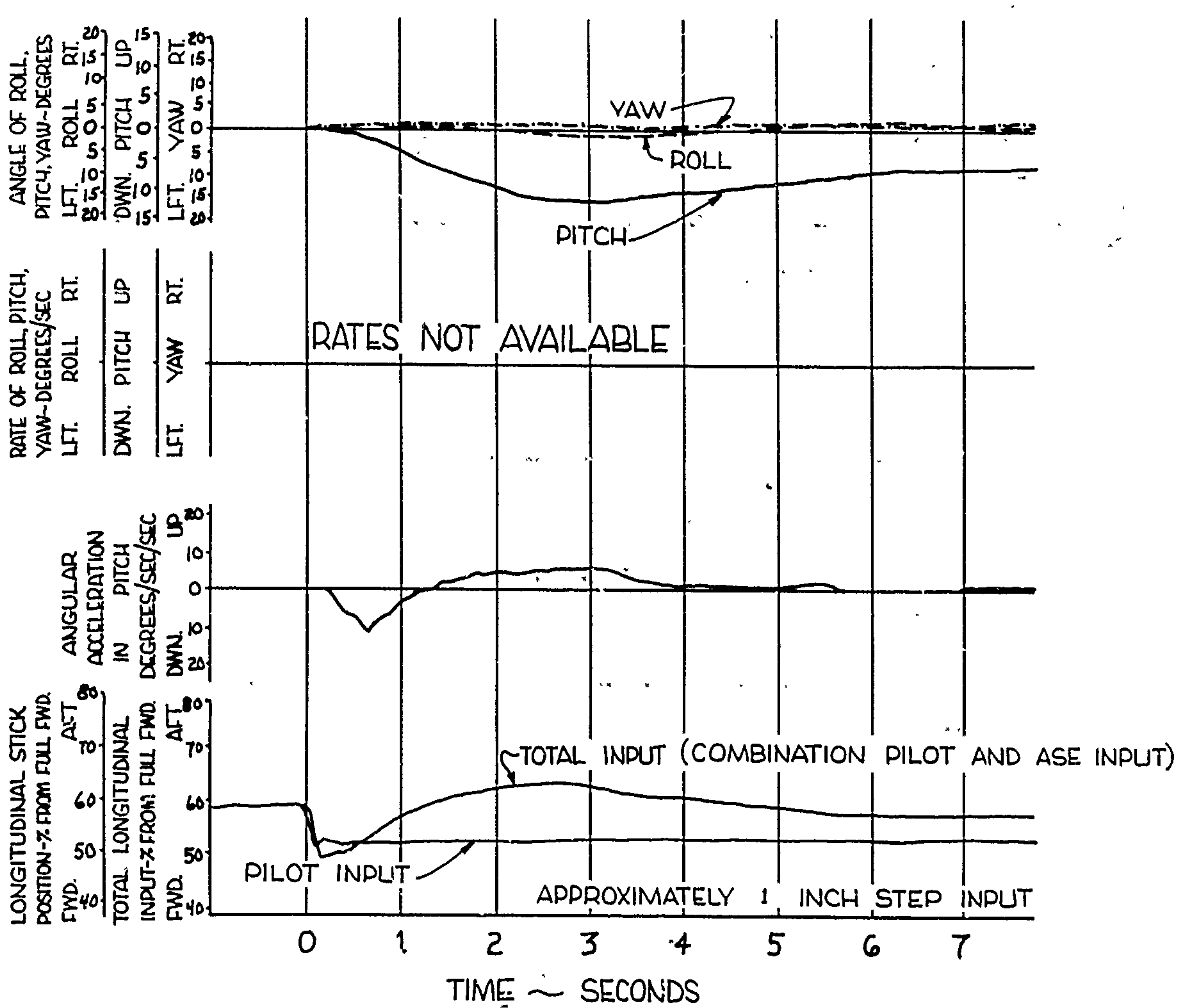


FIGURE NO.44
RESPONSE TO A FWD. LONGITUDINAL STEP ~ ASE ON
CH-37B, U.S.A., S/N 54-0998

FULL LONGITUDINAL TRAVEL = 16 INCHES
C.G. LOCATION = STATION 242
AVG. GROSS WEIGHT = 30,380 LB.
LEVEL FLIGHT
NOTE: TOTAL LONGITUDINAL INPUT IS LONG. STICK POSITION PLUS LONG. ASE POSITION.

TRIM CAS = 44 KNOTS
DENSITY ALTITUDE = 7110 FT.
RPM = 2605/186

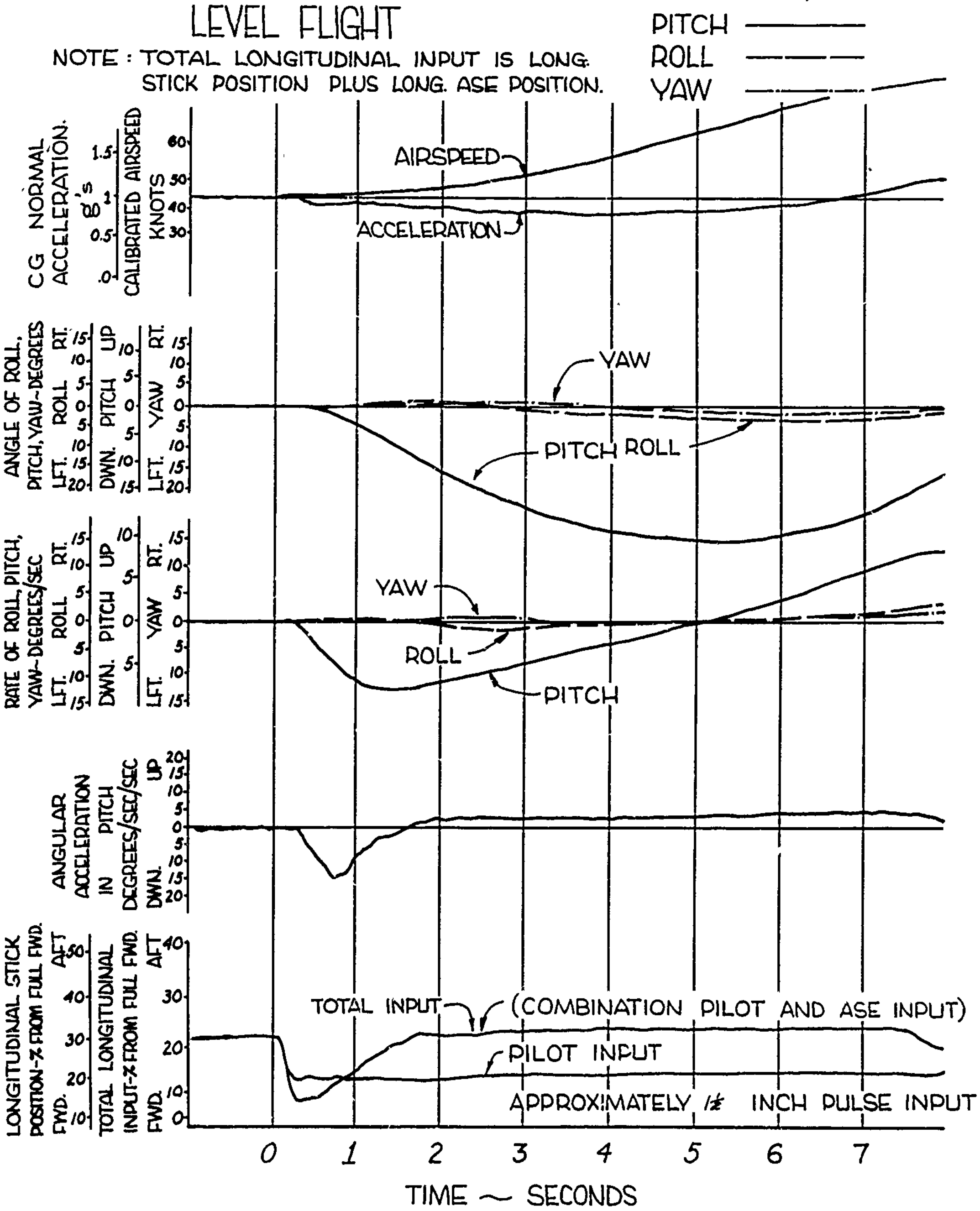


FIGURE NO.45
RESPONSE TO AN AFT LONGITUDINAL STEP ~ ASE ON
CH-37B, U.S.A., S/N 54-0998

FULL LONGITUDINAL TRAVEL = 16 INCHES
C.G. LOCATION = STATION 242
AVG. GROSS WEIGHT = 30,510 LB.

TRIM CAS = 45 KNOTS
DENSITY ALTITUDE = 6680 FT.
RPM = 2605/186

LEVEL FLIGHT

NOTE: TOTAL LONGITUDINAL INPUT IS LONG. STICK POSITION PLUS LONG. ASE POSITION.

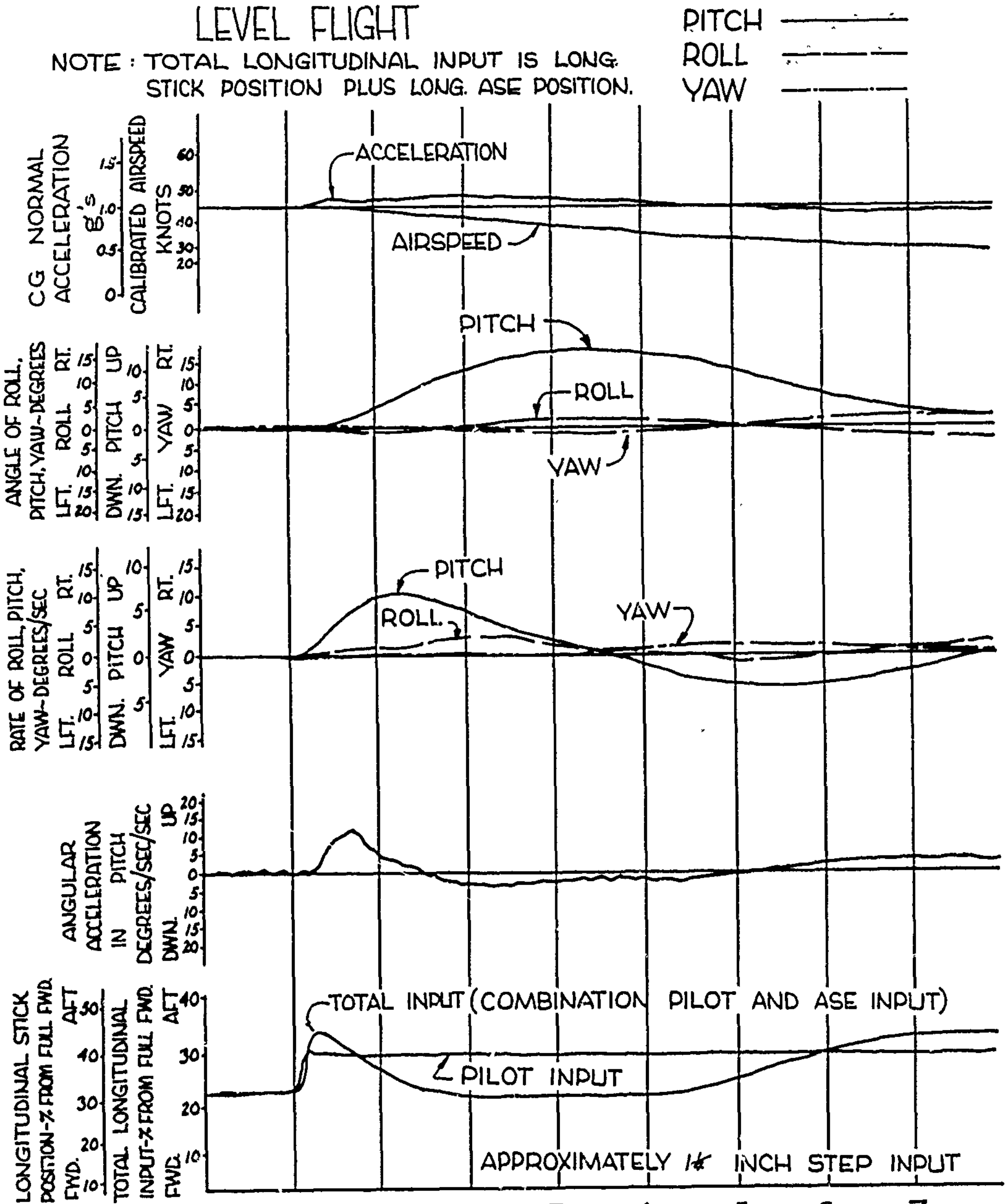


FIGURE NO.46
RESPONSE TO AN AFT LONGITUDINAL STEP ~ ASE ON
CH-37B, U.S.A., S/N 54-0998

FULL LONGITUDINAL TRAVEL = 16 INCHES
C.G. LOCATION = STATION 242
AVG. GROSS WEIGHT = 30,190 LB.

TRIM CAS = 87 KNOTS
DENSITY ALTITUDE = 7060 FT.
RPM = 2605/186

LEVEL FLIGHT

NOTE: TOTAL LONGITUDINAL INPUT IS LONG STICK POSITION PLUS LONG. ASE POSITION.

PITCH ————
ROLL — — — —
YAW —·—·—

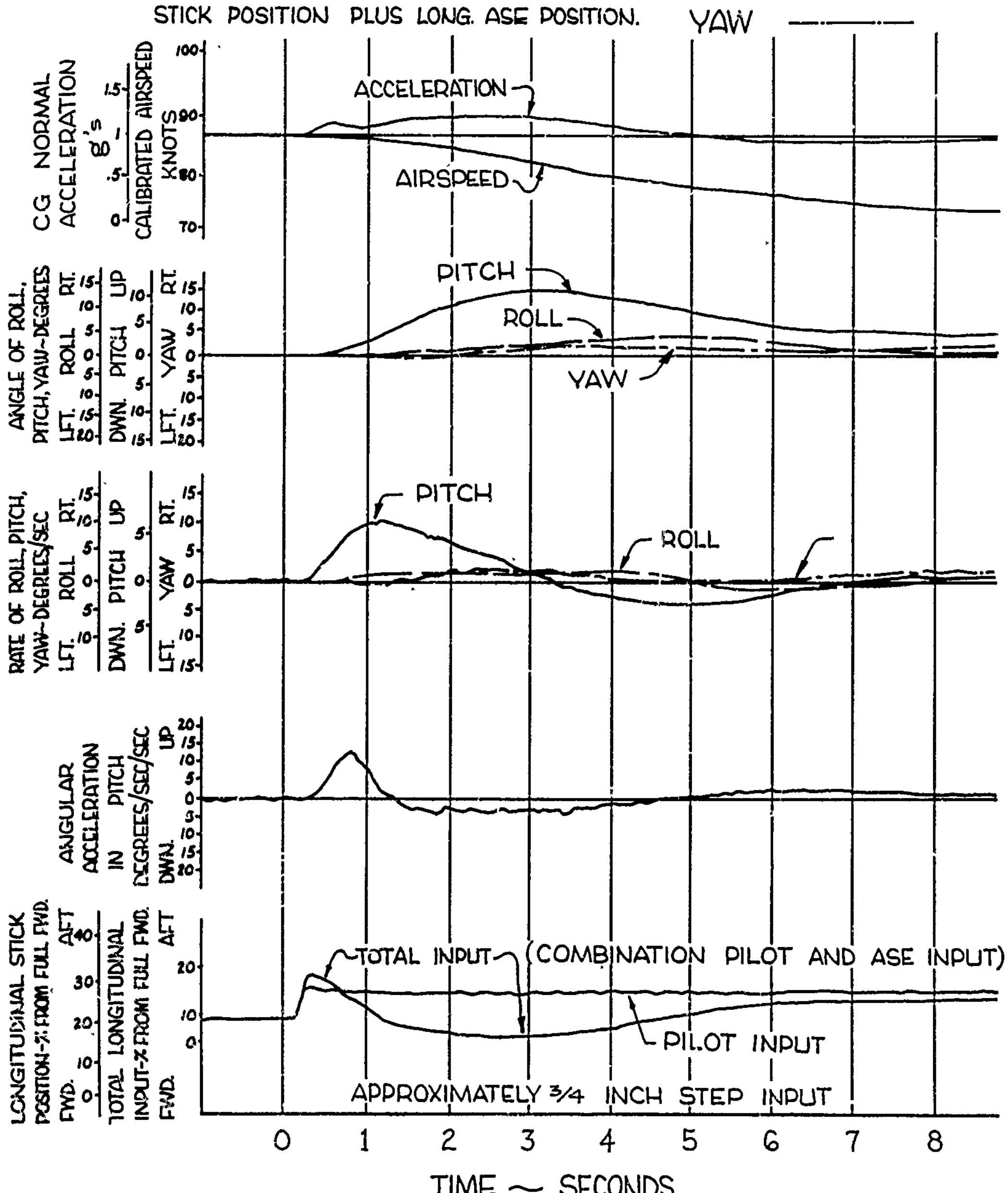


FIGURE NO.47
RESPONSE TO A LEFT LATERAL STEP ~~ASE OFF
CH-37B, U.S.A., S/N 54-998

FULL LATERAL TRAVEL = 15 INCHES
C.G. LOCATION = STATION 236.5 (MID)
AVG. GROSS WEIGHT = 30,500 LB.

TRIM CAS = 0 KNOTS
DENSITY ALTITUDE = 1000 FT.
RPM = 192 (ROTOR)

HOVER IGE

PITCH ————
ROLL — — —
YAW —·——

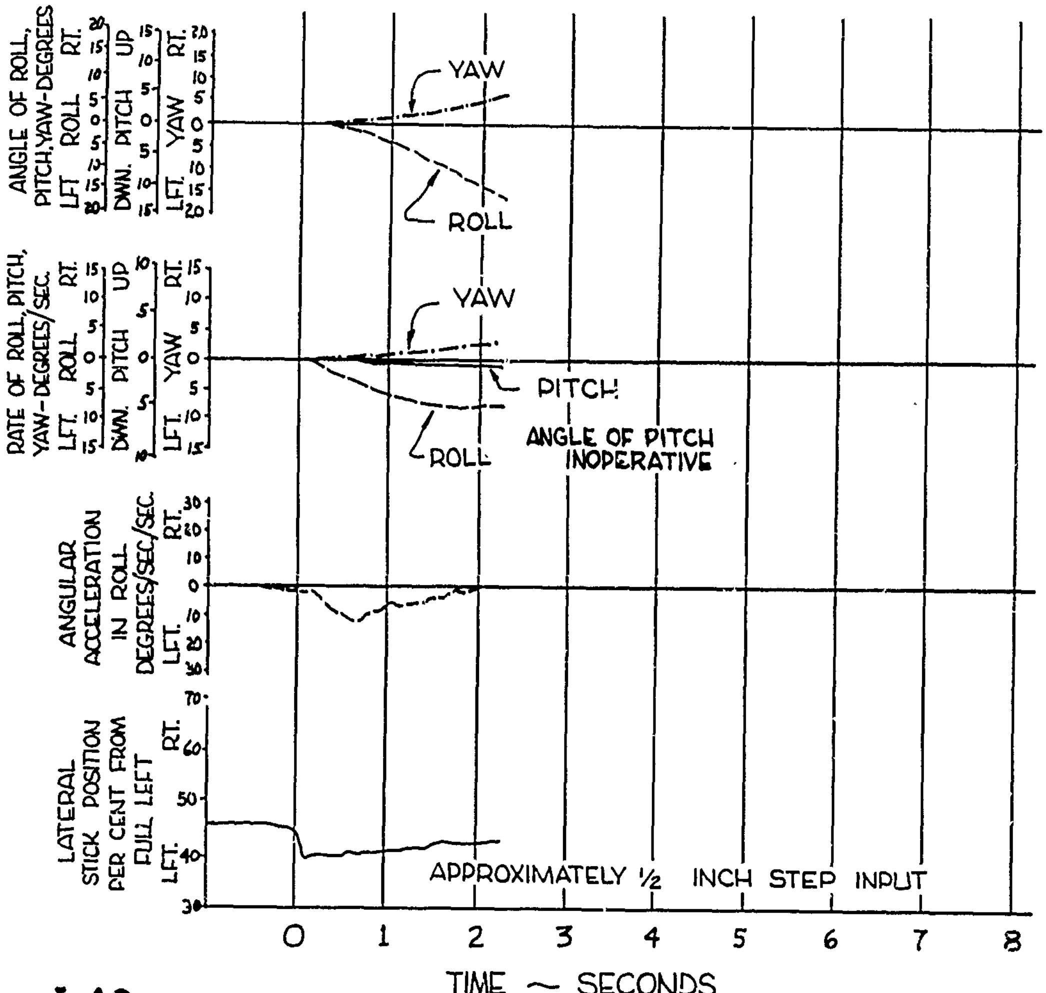


FIGURE NO.48
RESPONSE TO A LEFT LATERAL STEP ~ASE OFF
CH-37B, U.S.A., S/N 54-998

FULL LATERAL TRAVEL = 15 INCHES
C.G. LOCATION = STATION 242 (AFT OF MID)
AVG. GROSS WEIGHT = 30,675 LB.

TRIM CAS = 45 KNOTS
DENSITY ALTITUDE = 4990 FT.
RPM = 2630/188

LEVEL FLIGHT

PITCH ————
ROLL — — —
YAW —·—·—

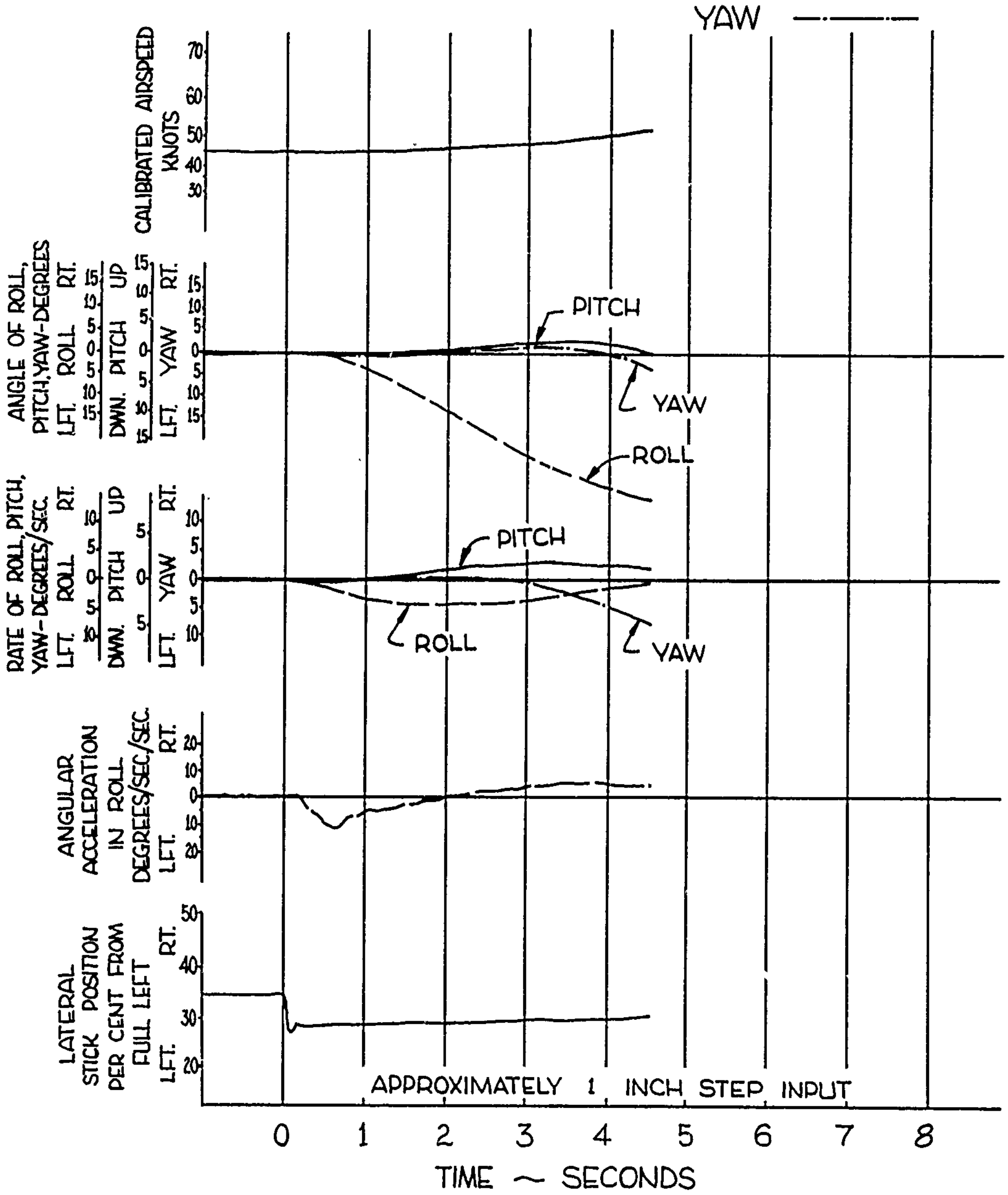


FIGURE NO.49
RESPONSE TO A RT. LATERAL STEP ~ASE OFF
CH-37B, U.S.A., S/N 54-998

FULL LATERAL TRAVEL = 15 INCHES
C.G. LOCATION = STATION 242 (AFT OF MID)
AVG. GROSS WEIGHT = 30,810 LB.

TRIM CAS = 45 KNOTS
DENSITY ALTITUDE = 5140 FT.
RPM = 2650/189

LEVEL FLIGHT

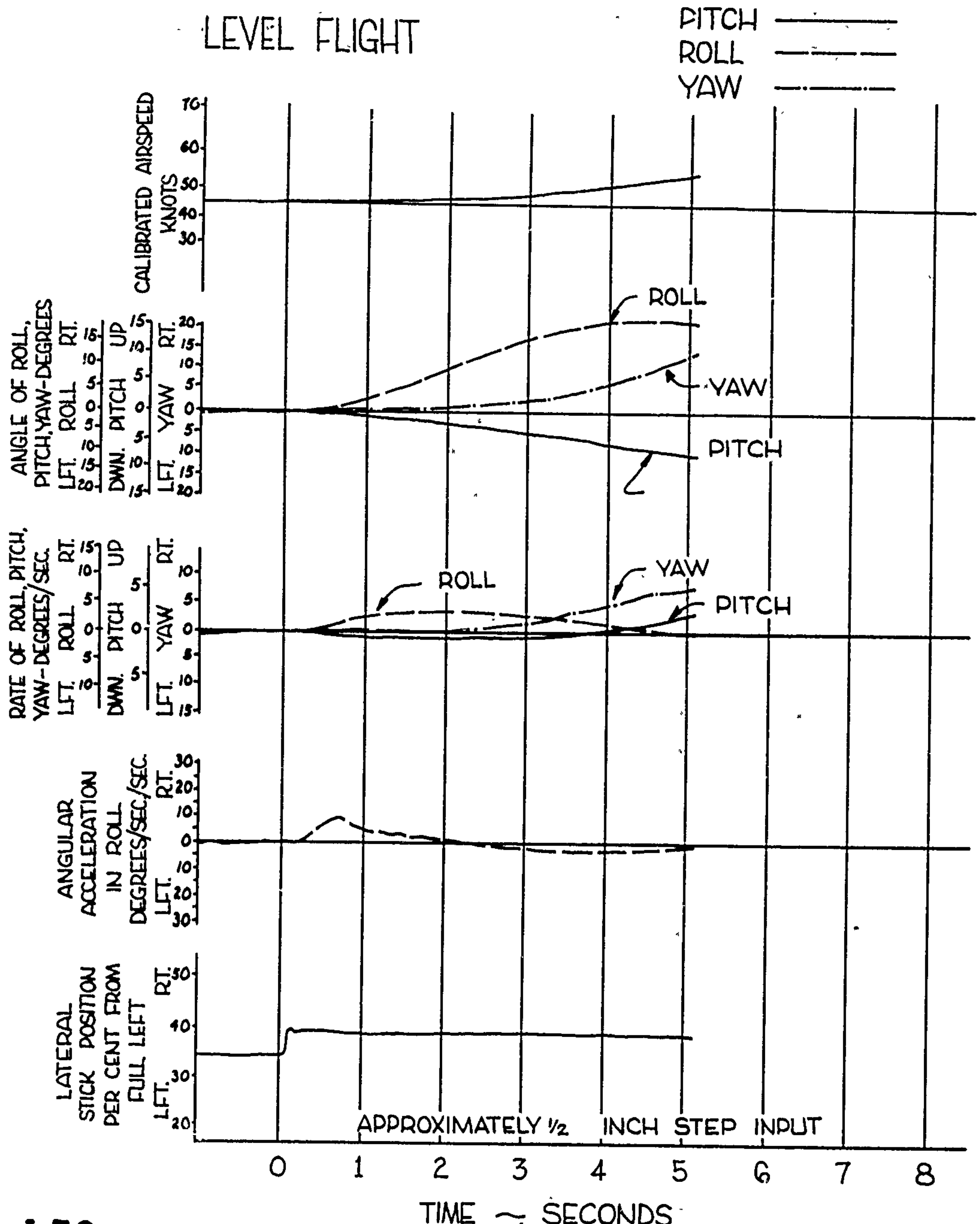


FIGURE NO:50
RESPONSE TO A LEFT LATERAL STEP ~ ASE OFF
CH-37B, U.S.A., S/N 54-998

FULL LATERAL TRAVEL = 15 INCHES
C.G. LOCATION = STATION 242
AVG. GROSS WEIGHT = 30,670 LB.

TRIM CAS = 83.5 KNOTS
DENSITY ALTITUDE = 6300 FT.
RPM = 2605/186

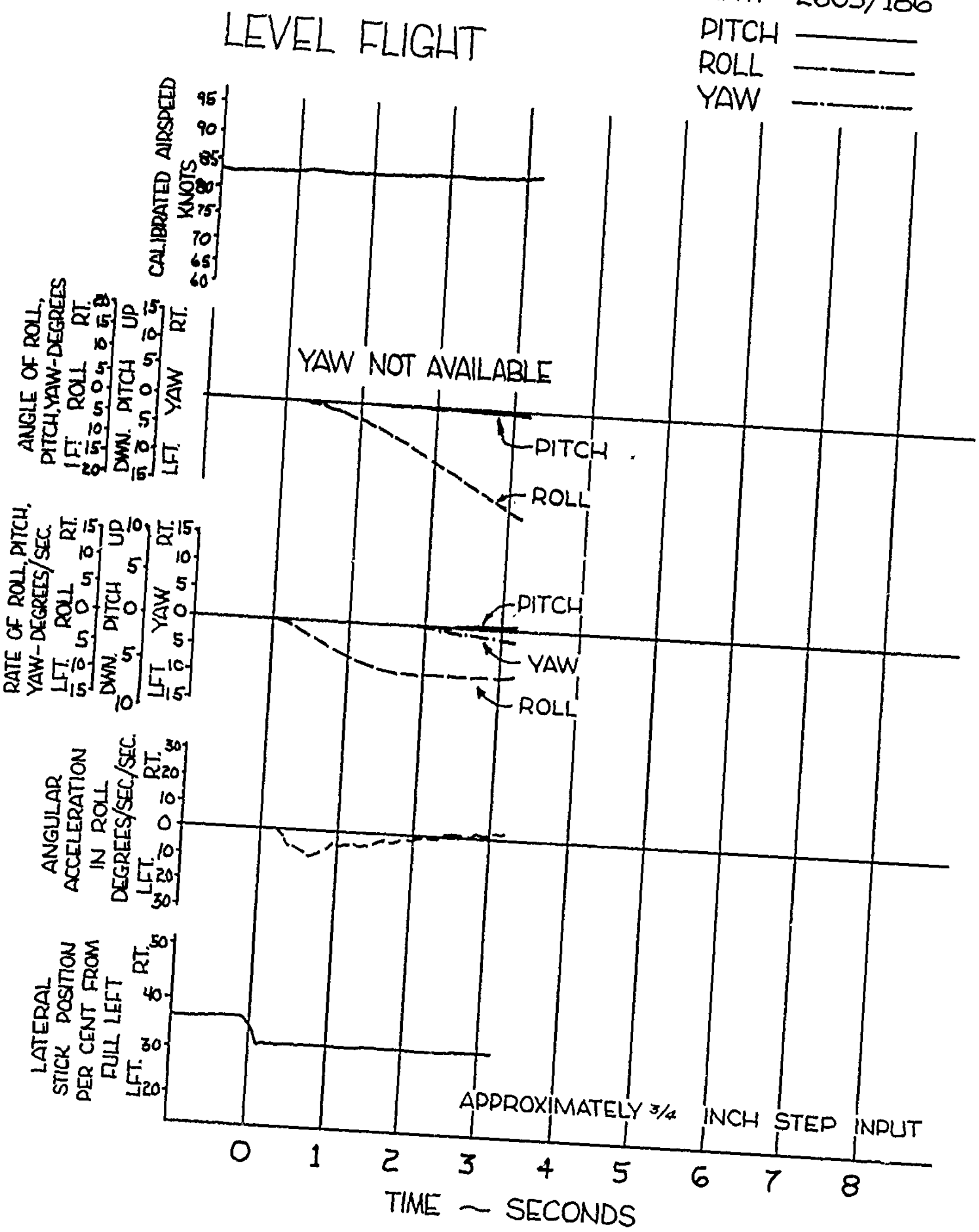


FIGURE NO.51
RESPONSE TO A LEFT LATERAL STEP ~ ASE ON
CH-37B, U.S.A., S/N 54-0998

FULL LATERAL TRAVEL = 15 INCHES
C.G. LOCATION - STATION 236.5 (MID)
AVG. GROSS WEIGHT = 29,700 LB.

HOVER

NOTE: TOTAL LATERAL INPUT IS LATERAL STICK POSITION PLUS LAT. ASE POSITION.

TRIM CAS = 0 KNOTS
DENSITY ALTITUDE = 1000 FT.
RPM = 194 (ROTOR)

PITCH ————
ROLL — — —
YAW —·—·—

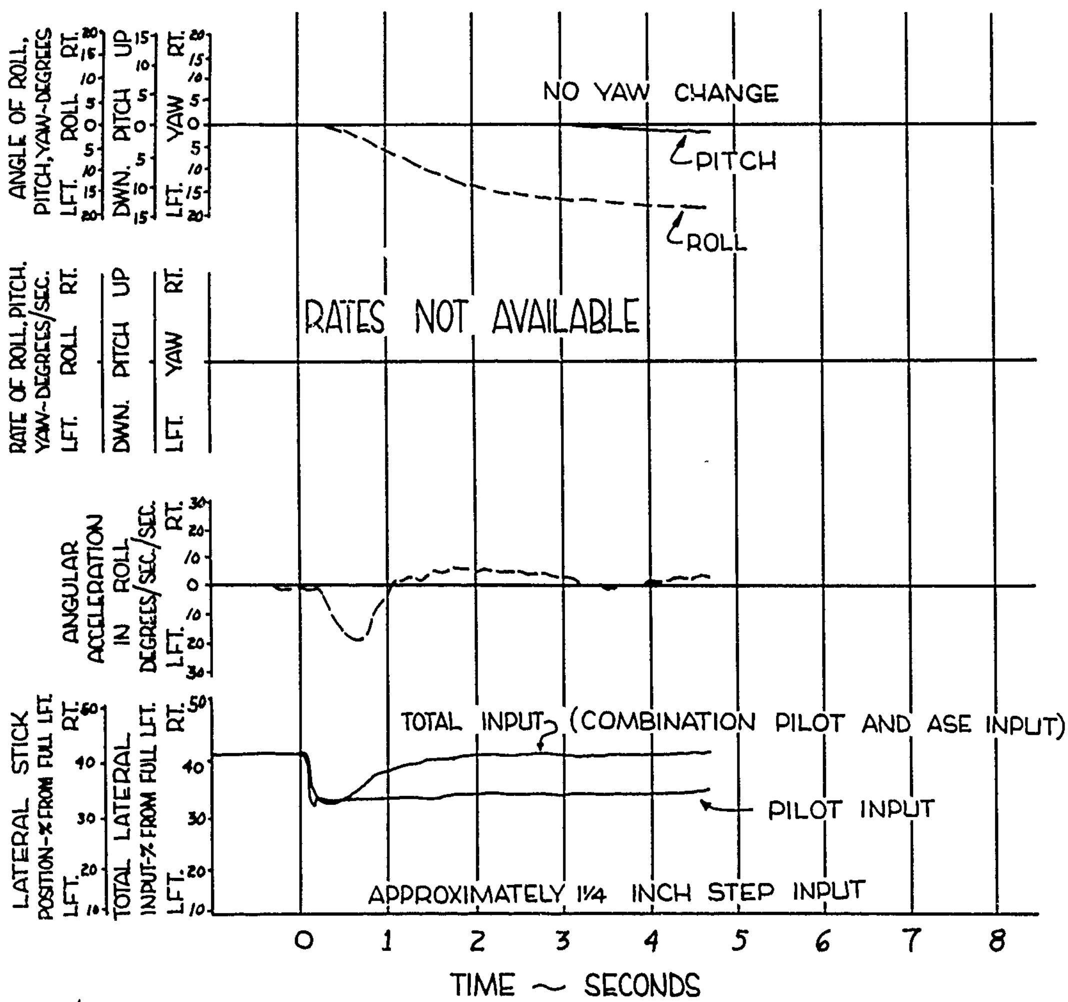


FIGURE NO.52
RESPONSE TO A LEFT LATERAL STEP ~ ASE ON
CH-37B, U.S.A., S/N 54-0998

FULL LATERAL TRAVEL = 15 INCHES
C.G. LOCATION = STATION 242
AVG. GROSS WEIGHT = 30,300 LB.

TRIM CAS = 44 KNOTS
DENSITY ALTITUDE = 7300 FT.
RPM = 2605/186

LEVEL FLIGHT

NOTE: TOTAL LATERAL INPUT IS LATERAL STICK POSITION PLUS LAT. ASE POSITION.

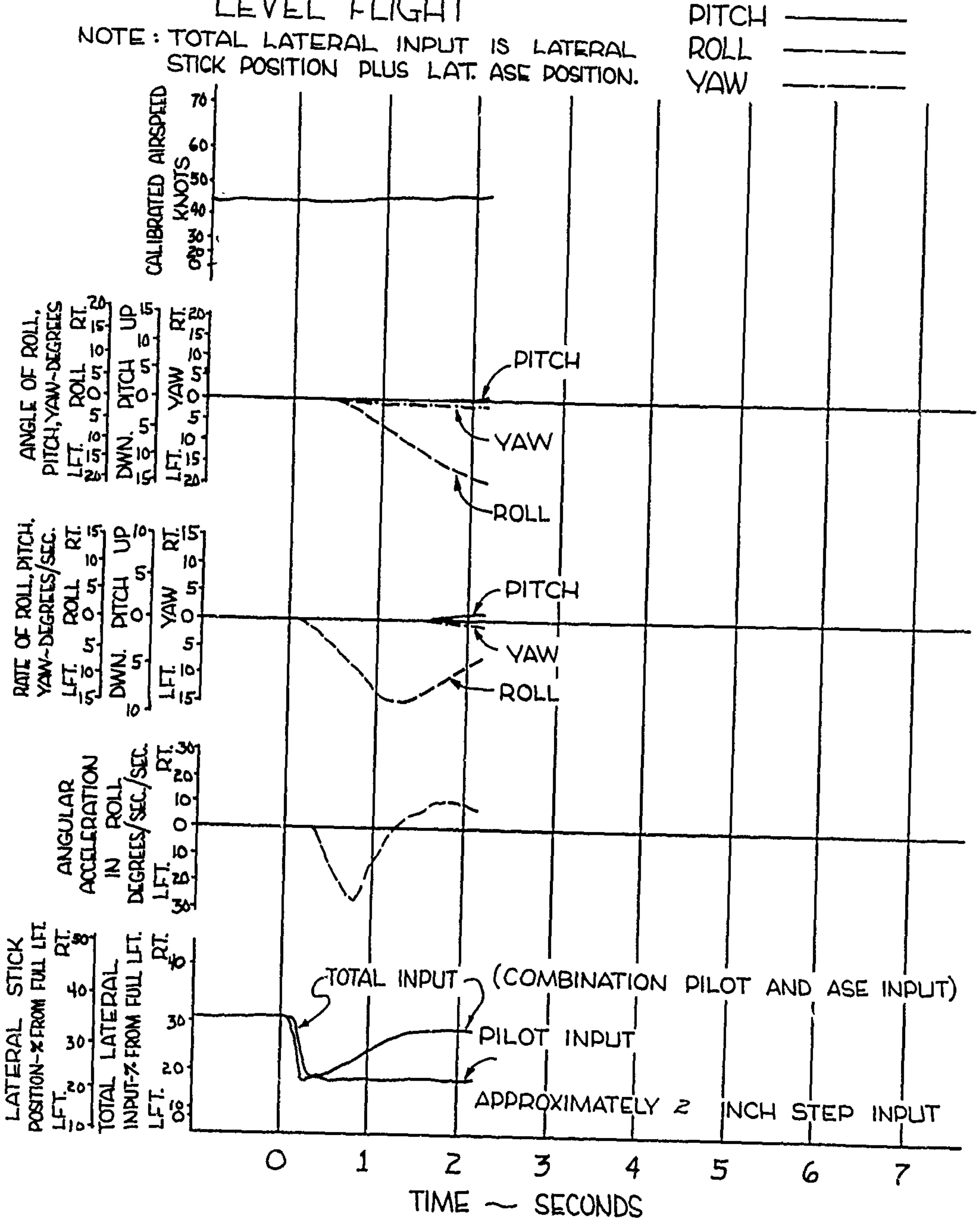


FIGURE NO. 53
RESPONSE TO A LEFT LATERAL STEP ~ ASE ON CH-37B, U.S.A., S/N 54-0998

FULL LATERAL TRAVEL = 15 INCHES
C.G. LOCATION = STATION 242
AVG. GROSS WEIGHT = 30,020 LB.

TRIM CAS = 88 KNOTS
DENSITY ALTITUDE = 6560 FT.
RPM = 2605/186

LEVEL FLIGHT

NOTE: TOTAL LATERAL INPUT IS LATERAL STICK POSITION PLUS LAT. ASE POSITION.

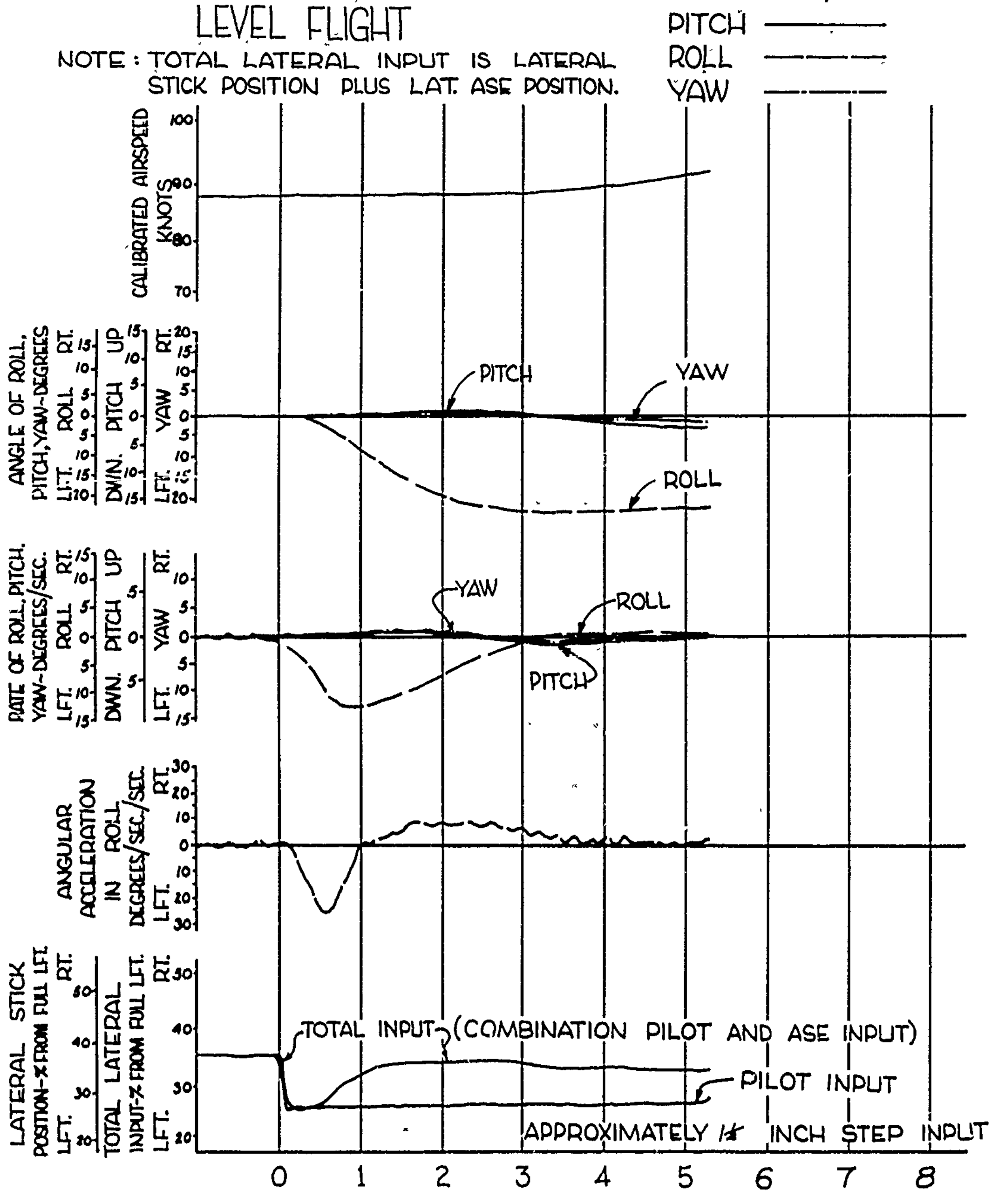


FIGURE NO. 54
RESPONSE TO A LEFT DIRECTIONAL STEP—ASE OFF
CH-37B, U.S.A., S/N 54-0998

FULL PEDAL TRAVEL = 3.8 INCHES
C.G. LOCATION = STATION 236.5 (MID)
AVG. GROSS WEIGHT = 30,000 LB.

TRIM CAS = 0 KNOTS
DENSITY ALTITUDE = 1000 FT.
RPM = 2750/196

HOVER (IGE)

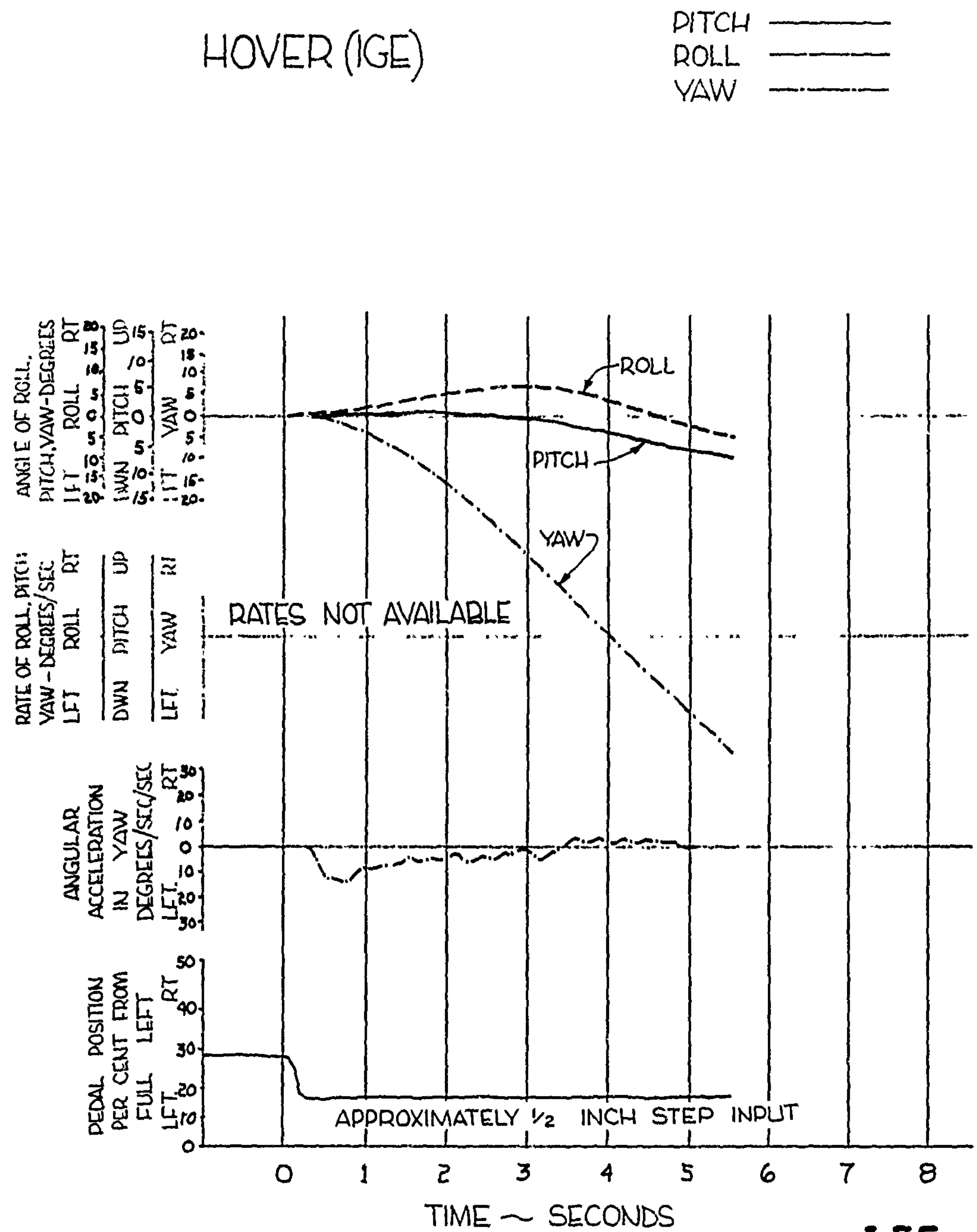


FIGURE NO. 55
RESPONSE TO A RIGHT DIRECTIONAL STEP - ASE OFF
CH-37B, U.S.A., S/N 54-0998

FULL PEDAL TRAVEL = 3.8 INCHES
C.G. LOCATION = STATION 242
AVG. GROSS WEIGHT = 30,540 LB.

TRIM CAS = 46 KNOTS
DENSITY ALTITUDE = 5140 FT.
RPM = 2630/188

LEVEL FLIGHT

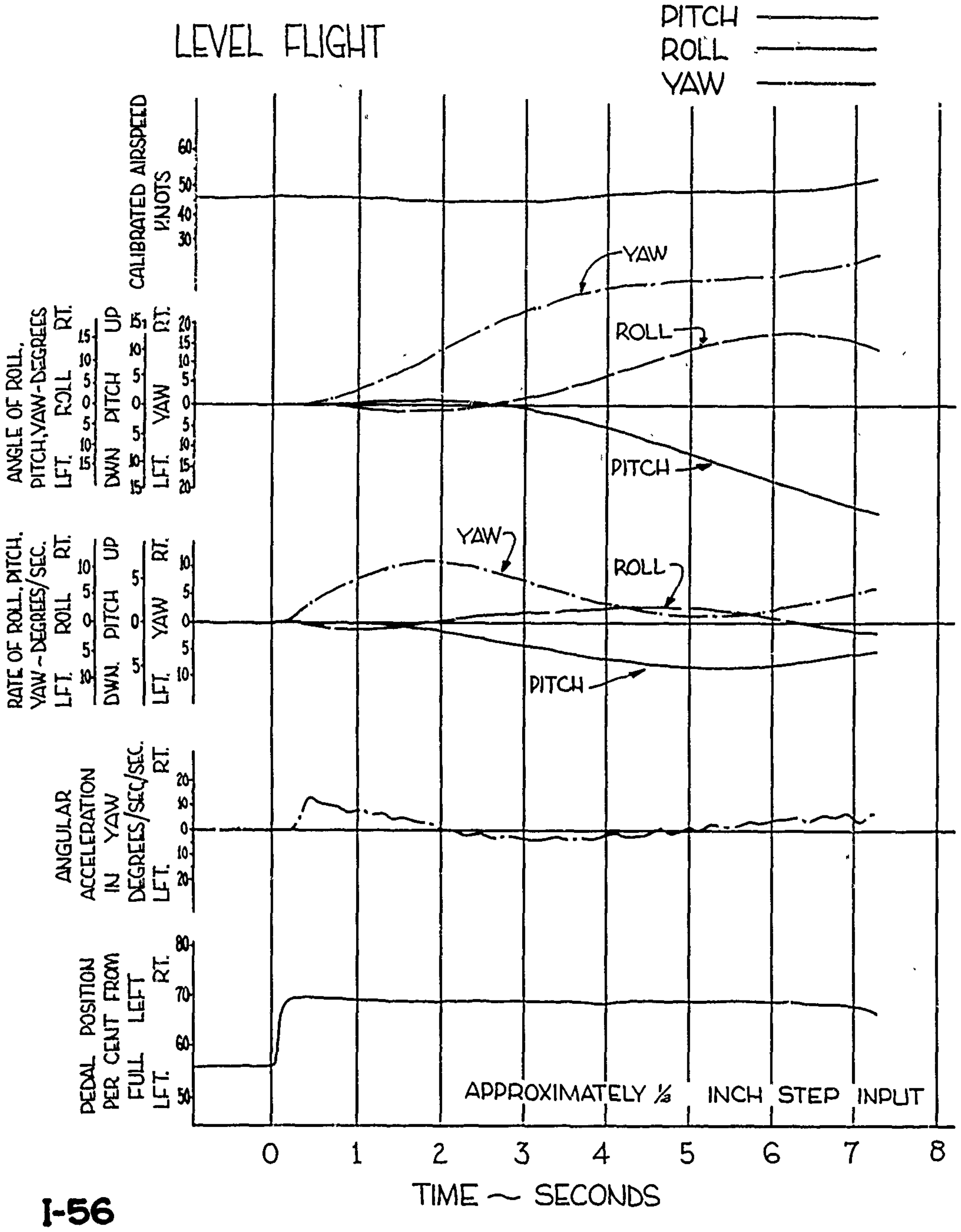


FIGURE NO. 56
RESPONSE TO A LEFT DIRECTIONAL STEP — ASE OFF
CH-37B, U.S.A., S/N 54-0998

FULL PEDAL TRAVEL = 3.8 INCHES
C.G. LOCATION = STATION 242
AVG. GROSS WEIGHT = 30,380 LB.

TRIM CAS = 87 KNOTS
DENSITY ALTITUDE = 6340 FT.
RPM = 2605/186

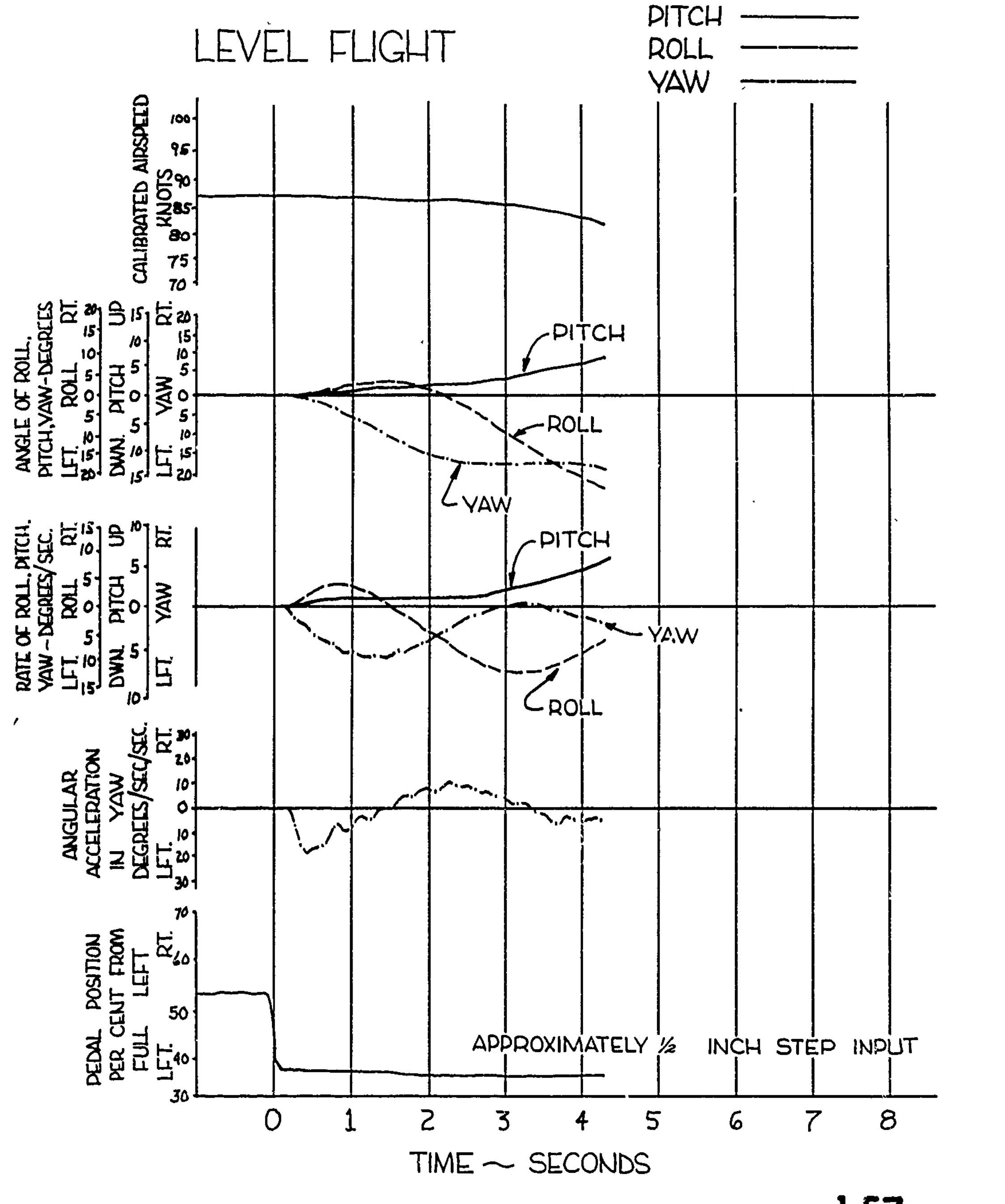


FIGURE NO. 57
RESPONSE TO A LEFT DIRECTIONAL STEP ~ ASE ON
CH-37B, U.S.A., S/N 54-0998

FULL PEDAL TRAVEL = 3.8 INCHES
C.G. LOCATION = STATION 236.5 (MID)
AVG. GROSS WEIGHT = 29,900 LB.
HOVER (IGE)
NOTE: TOTAL PEDAL INPUT IS PEDAL POSITION PLUS PEDAL ASE POSITION.

TRIM CAS = 0 KNOTS
DENSITY ALTITUDE = 2100 FT.
RPM = 2710/193
PITCH
ROLL
YAW

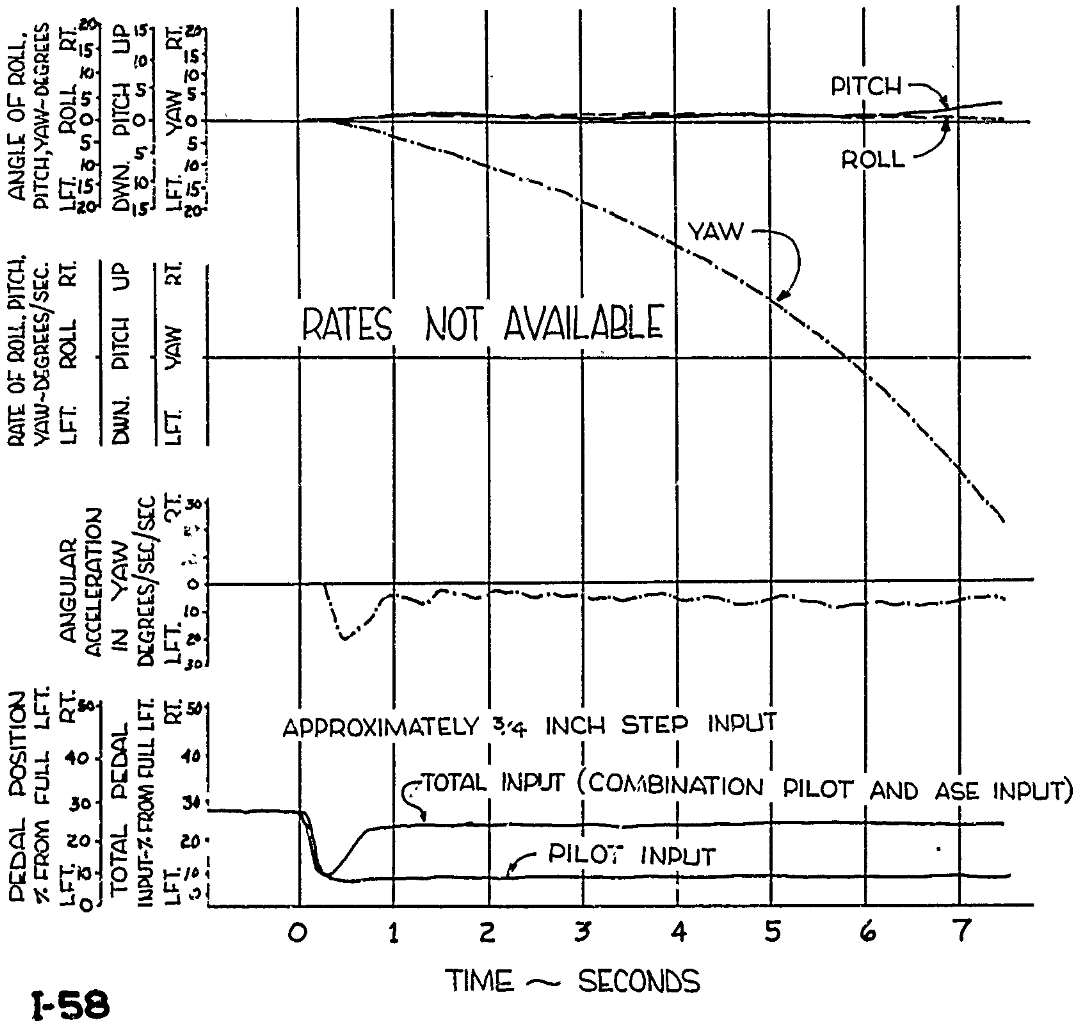


FIGURE NO. 58
RESPONSE TO A LFT. DIRECTIONAL STEP ~ ASE ON
CH-37B, U.S.A., S/N 54-0998

FULL PEDAL TRAVEL = 3.8 INCHES
C.G. LOCATION = STATION 242
AVG. GROSS WEIGHT = 30,030 LB.

TRIM CAS = 45 KNOTS
DENSITY ALTITUDE = 7450 FT.
RPM = 2605/186

LEVEL FLIGHT

NOTE: TOTAL PEDAL INPUT IS PEDAL POSITION PLUS PEDAL ASE POSITION.

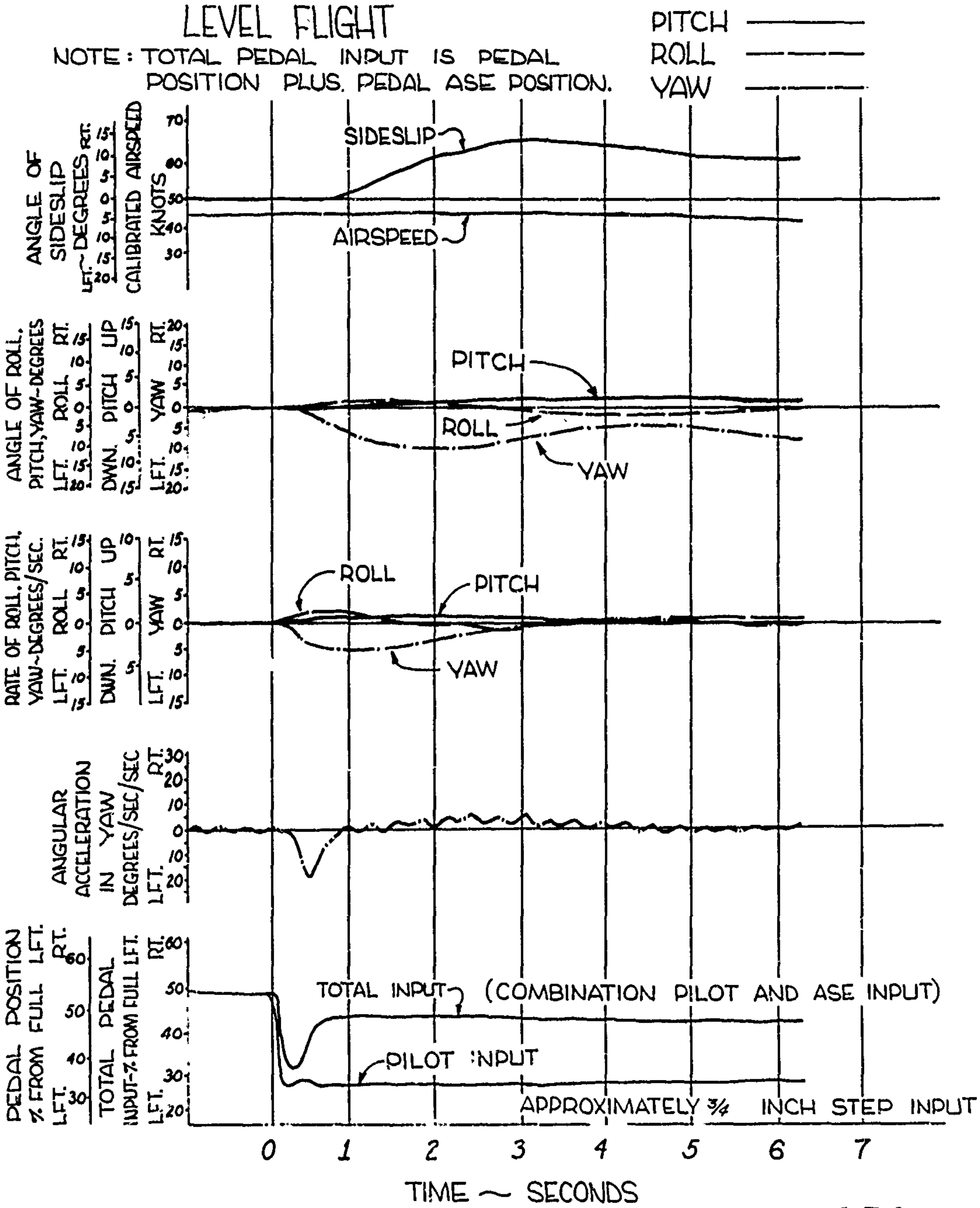


FIGURE NO.59

RESPONSE TO A RT. DIRECTIONAL STEP ~ ASE ON CH-37B, U.S.A., S/N 54-0998

FULL PEDAL TRAVEL = 3.8 INCHES
C.G. LOCATION = STATION 242
AVG. GROSS WEIGHT = 29,940 LB.

TRIM CAS = 83 KNOTS
DENSITY ALTITUDE = 6820 FT.
RPM = 2605/186

LEVEL FLIGHT

NOTE: TOTAL PEDAL INPUT IS PEDAL POSITION PLUS PEDAL ASE POSITION.

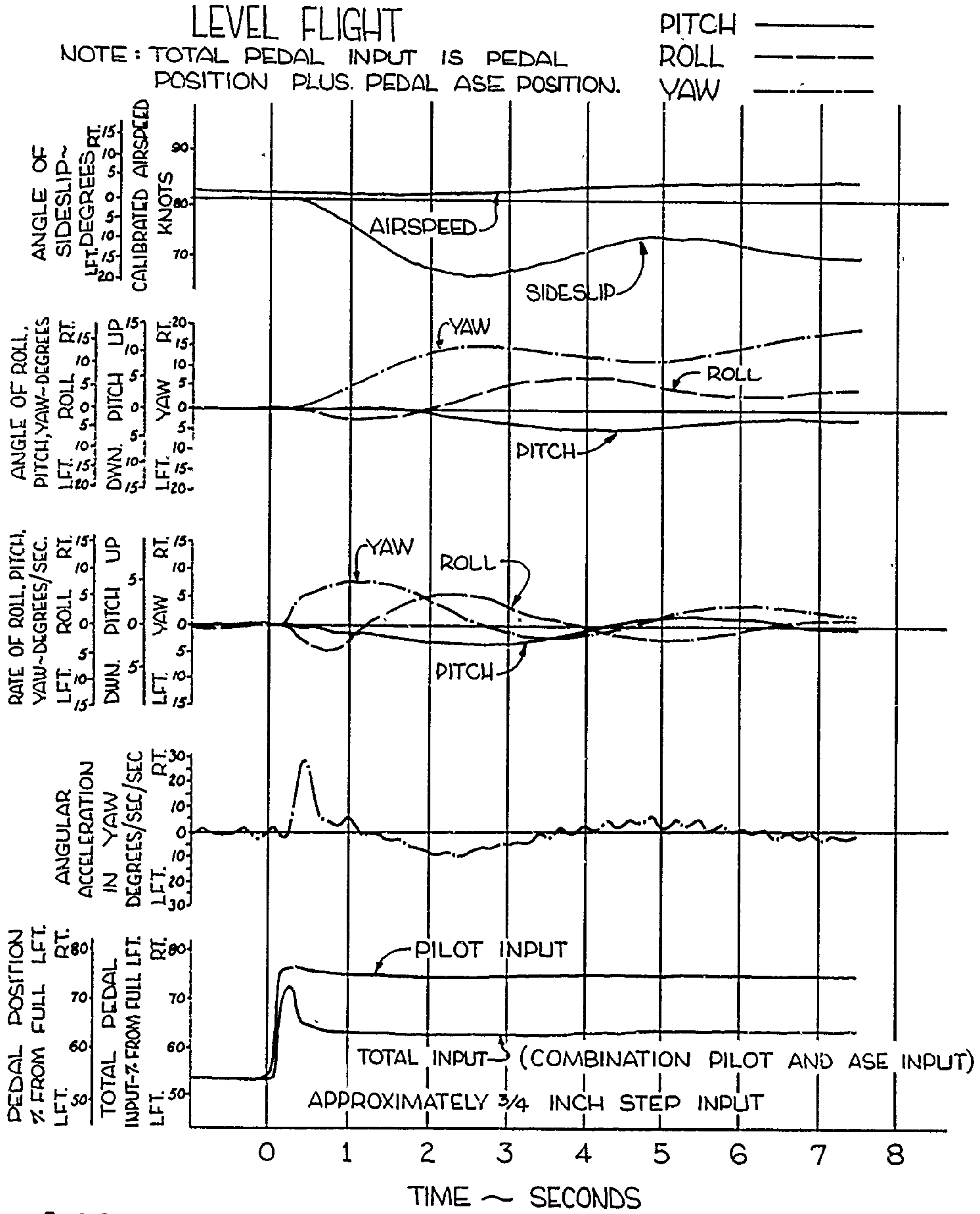


FIGURE NO.60
RESPONSE TO AN AFT LONGITUDINAL HARD-OVER
CH-37B, U.S.A., S/N 54-0998

FULL LONGITUDINAL TRAVEL = 16 INCHES
C.G. LOCATION = STATION 236.5 (MID)
AVG. GROSS WEIGHT = 26,140 LB.
LEVEL FLIGHT
NOTE: TOTAL LONGITUDINAL INPUT IS LONG. STICK POSITION PLUS LONG. ASE POSITION.

TRIM CAS = 85 KNOTS
DENSITY ALTITUDE = 8410 FT.
RPM = 2605/186
PITCH
ROLL
YAW

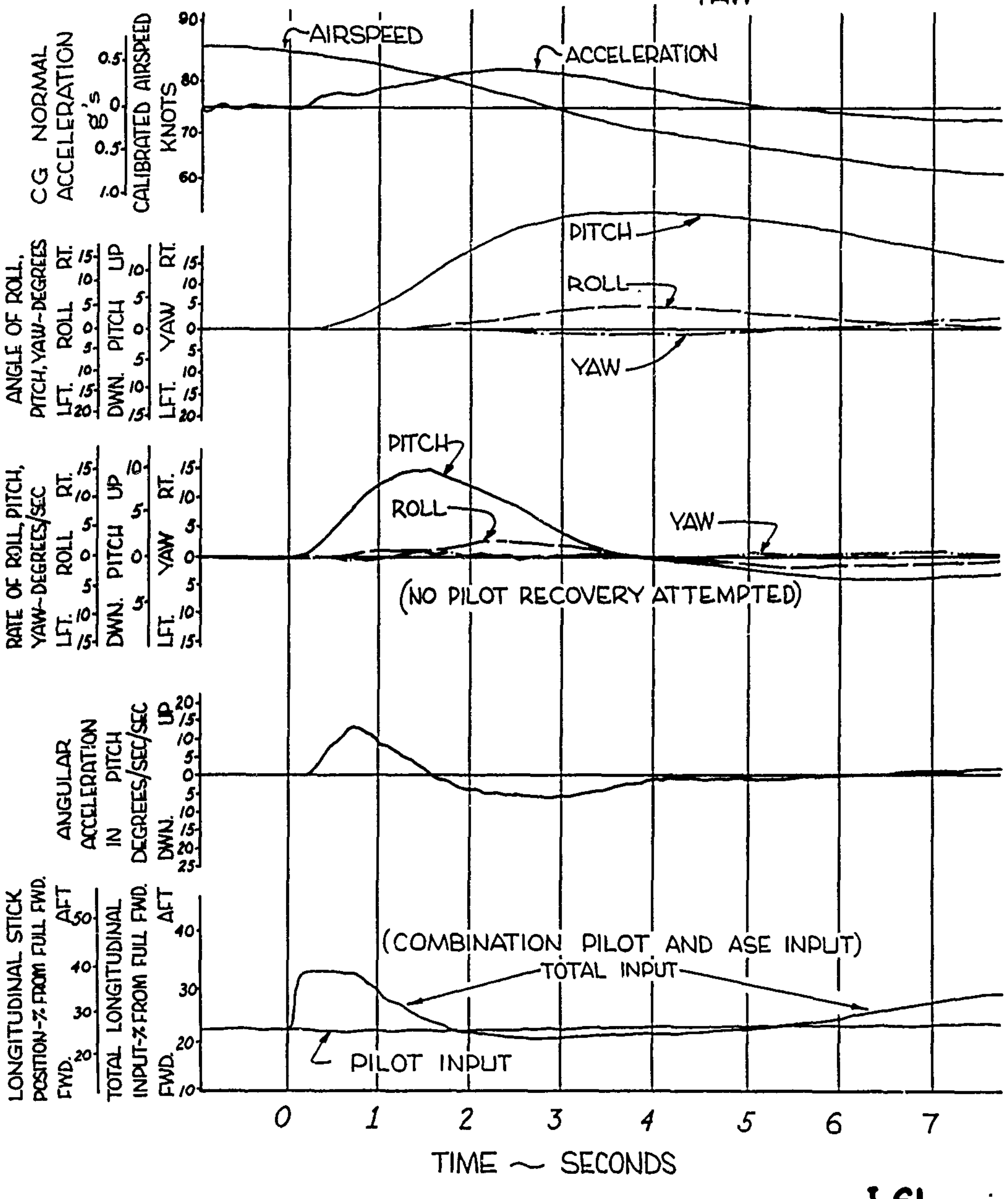


FIGURE NO. 61
RESPONSE TO AN AFT LONGITUDINAL HARD-OVER WITH RECOVERY
CH-37B, U.S.A., S/N 54-0998

FULL LONGITUDINAL TRAVEL = 16 INCHES
C.G. LOCATION = STATION 236.5 (MID)
AVG. GROSS WEIGHT = 26,070 LB.

TRIM CAS = 83 KNOTS
DENSITY ALTITUDE = 8700 FT.
RPM = 2605/186

LEVEL FLIGHT

NOTE: TOTAL LONGITUDINAL INPUT IS LONG. STICK POSITION PLUS LONG. ASE POSITION.

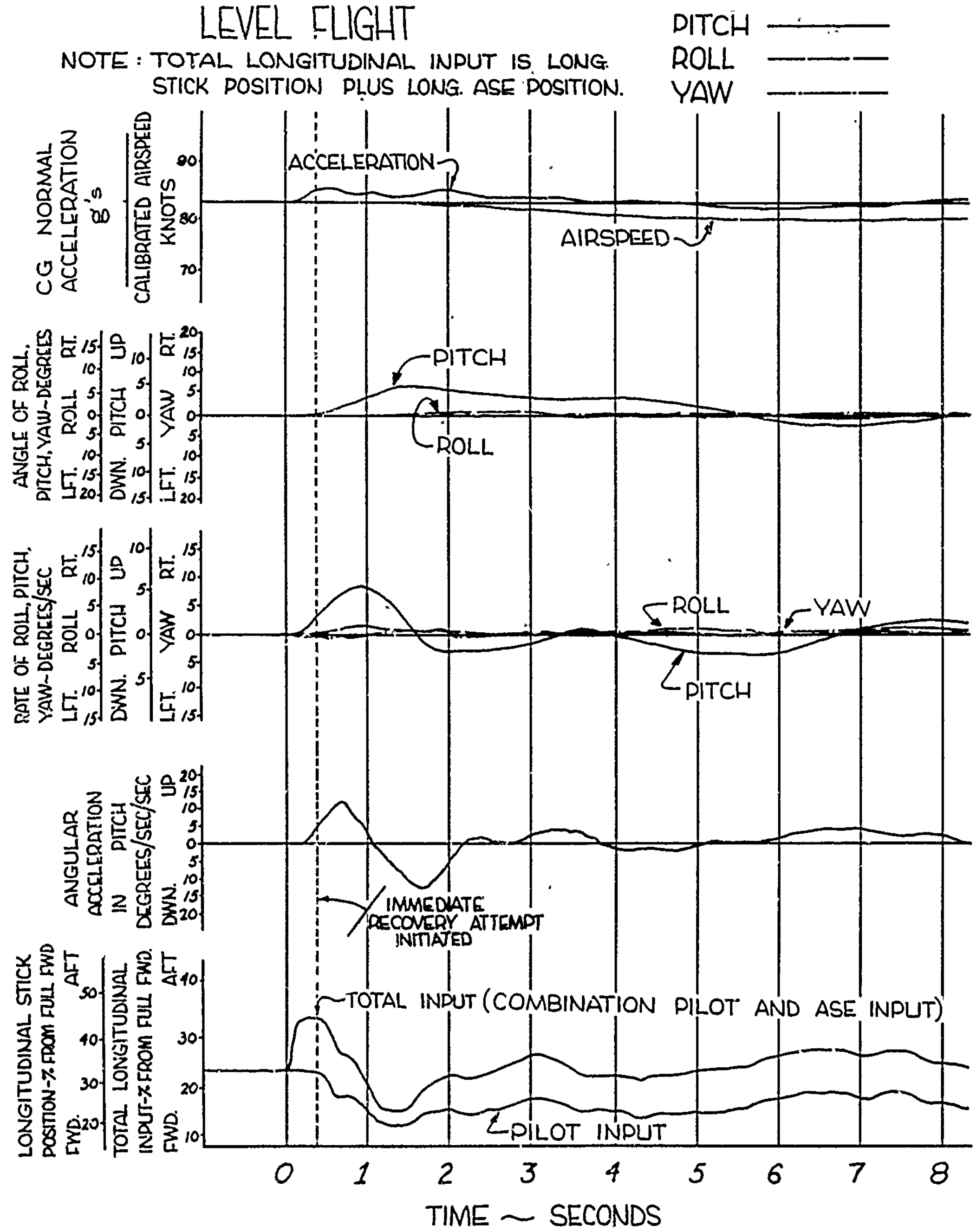


FIGURE NO. 62
RESPONSE TO A FWD. LONGITUDINAL HARD-OVER
CH-37B, U.S.A., S/N 54-0998

FULL LONGITUDINAL TRAVEL = 16 INCHES
C.G. LOCATION = STATION 236.5 (MID)
AVG. GROSS WEIGHT = 26,090 LB.

TRIM CAS = 85 KNOTS
DENSITY ALTITUDE = 8700 FT.
RPM = 2605/186

LEVEL FLIGHT

NOTE: TOTAL LONGITUDINAL INPUT IS LONG. STICK POSITION PLUS LONG. ASE POSITION.

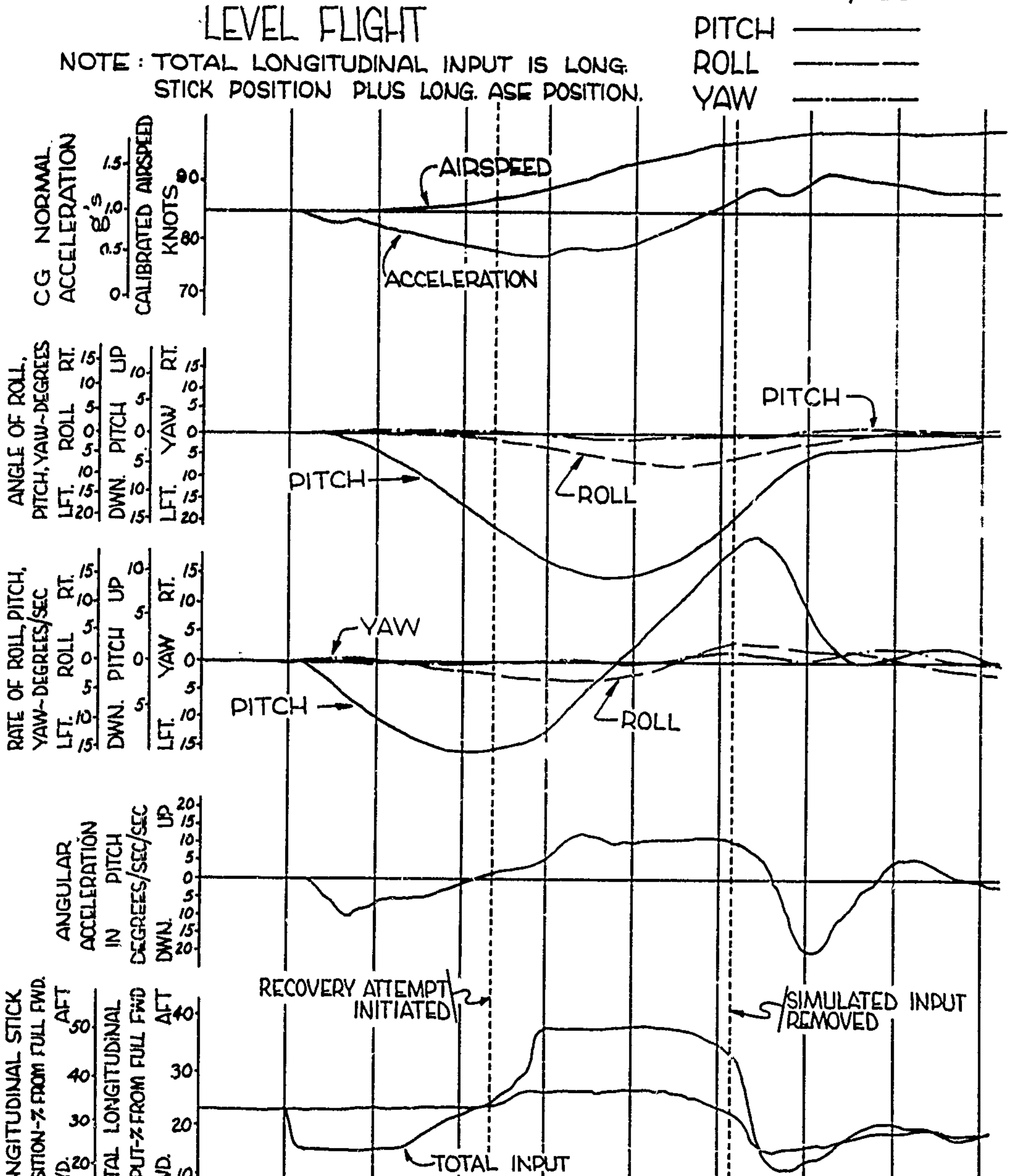


FIGURE NO. 63
RESPONSE TO A RT. LATERAL HARD-OVER WITH RECOVERY
CH-37B, U.S.A., S/N 54-0998

FULL LATERAL TRAVEL = 15 INCHES
C.G. LOCATION = STATION 236.5 (MID)
AVG. GROSS WEIGHT = 25,960 LB.

TRIM CAS = 85 KNOTS
DENSITY ALTITUDE = 9015 FT.
RPM = 2605/186

LEVEL FLIGHT

NOTE: TOTAL LATERAL INPUT IS LATERAL STICK POSITION PLUS LAT. ASE POSITION.

PITCH ————
ROLL — — —
YAW —·—·—

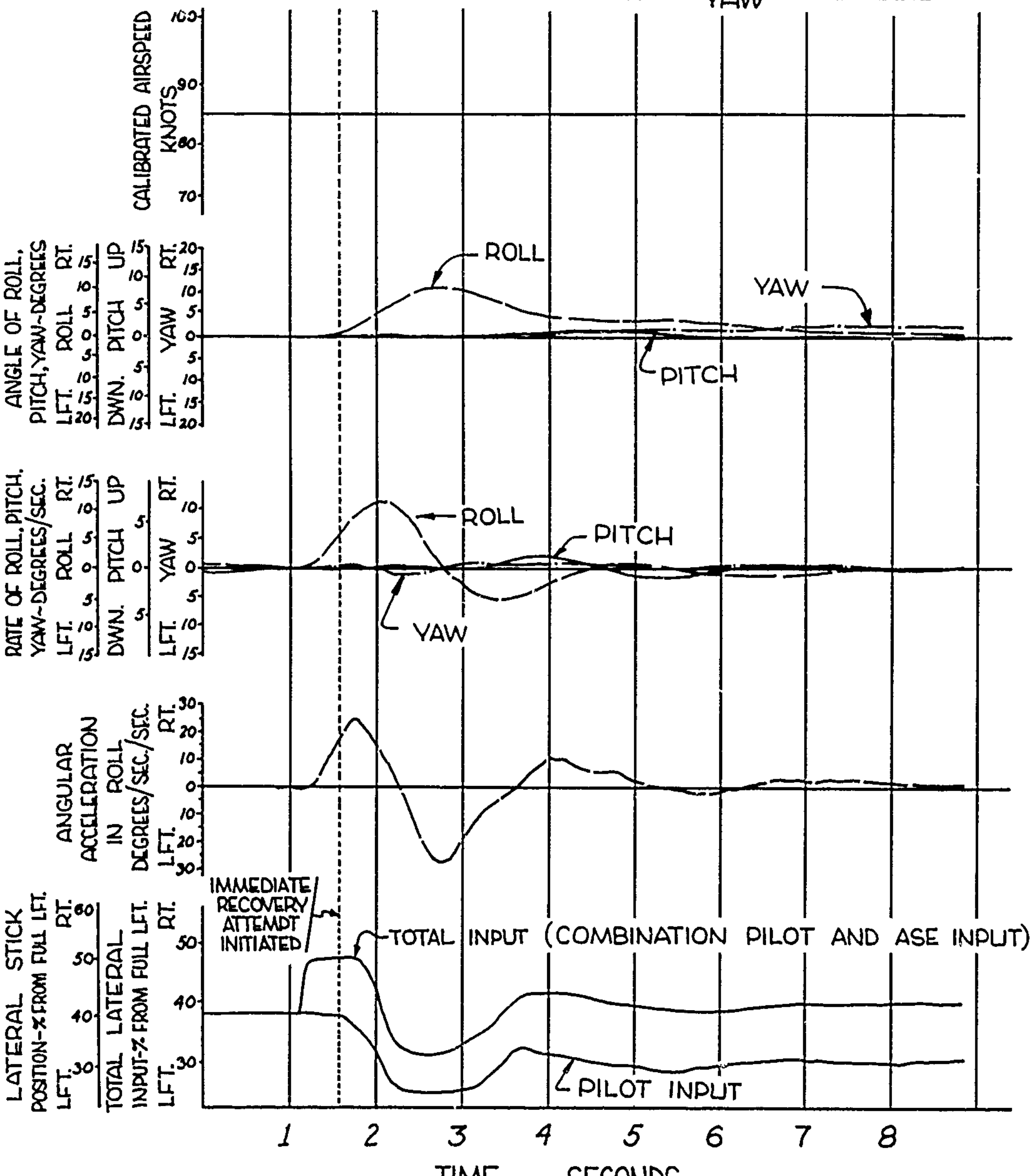


FIGURE NO.64
RESPONSE TO A LFT. LATERAL HARD-OVER
WITH RECOVERY
CH-37B, U.S.A. S/N 54-0998

FULL LATERAL TRAVEL = 15 INCHES
C.G. LOCATION = STATION 236.5 (MID)
AVG. GROSS WEIGHT = 25,900 LB.

TRIM CAS = 83 KNOTS
DENSITY ALTITUDE = 8270 FT.
RPM = 2605/186

LEVEL FLIGHT

NOTE: TOTAL LATERAL INPUT IS LATERAL STICK POSITION PLUS LAT. ASE POSITION.

PITCH ————
ROLL — — —
YAW —·—·—

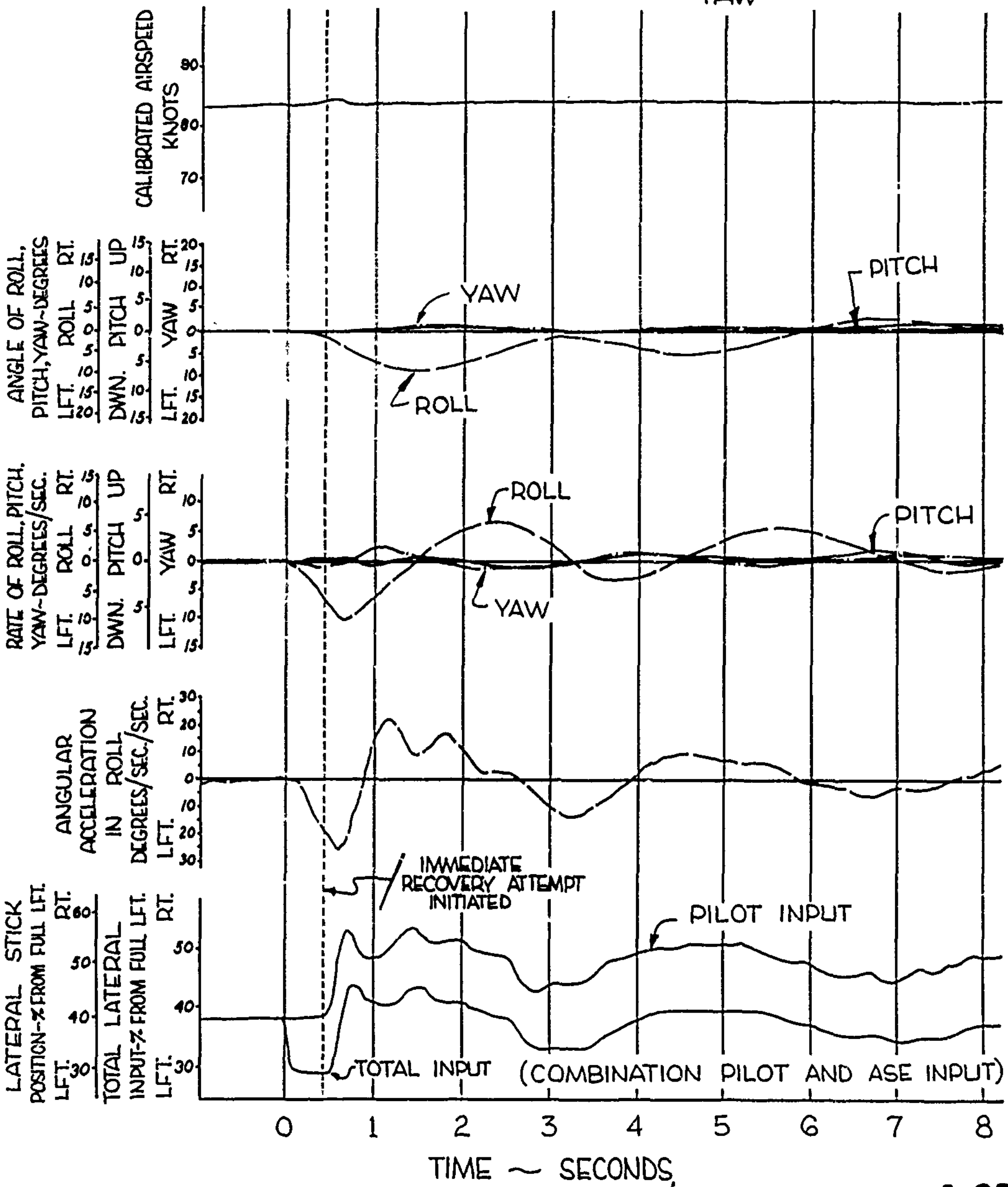


FIGURE NO. 65
RESPONSE TO A RT. DIRECTIONAL HARD-OVER
CH-37B, U.S.A., S/N 54-0998

FULL PEDAL TRAVEL = 3.8 INCHES
C.G. LOCATION = STATION 236.5 (MID)
AVG. GROSS WEIGHT = 25,440 LB.

TRIM CAS = 62 KNOTS
DENSITY ALTITUDE = 7,550 FT.
RPM = 192 (ROTOR)

AUTOROTATION

NOTE: TOTAL PEDAL INPUT IS PEDAL POSITION PLUS PEDAL ASE POSITION.

PITCH ————
ROLL — — — —
YAW —·—·—

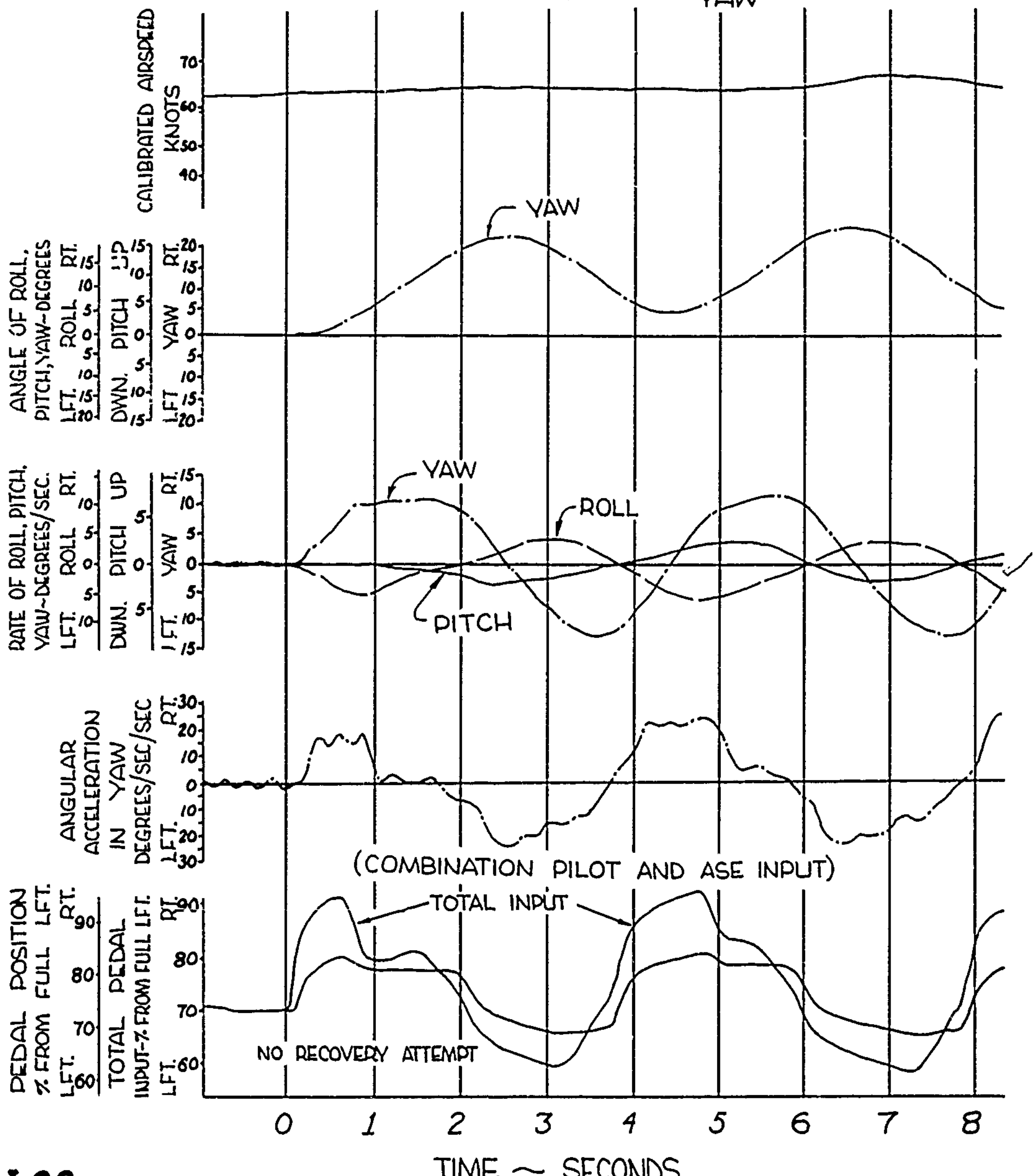


FIGURE NO.66
RESPONSE TO A LFT. DIRECTIONAL HARD-OVER
CH-37B, U.S.A., S/N 54-0998

FULL PEDAL TRAVEL = 3.8 INCHES
C.G. LOCATION = STATION 236.5 (MID)
AVG. GROSS WEIGHT = 25,820 LB.

TRIM CAS = 83 KNOTS
DENSITY ALTITUDE = 9030 FT.
RPM = 2605/186

LEVEL FLIGHT

NOTE: TOTAL PEDAL INPUT IS PEDAL POSITION PLUS PEDAL ASE POSITION.

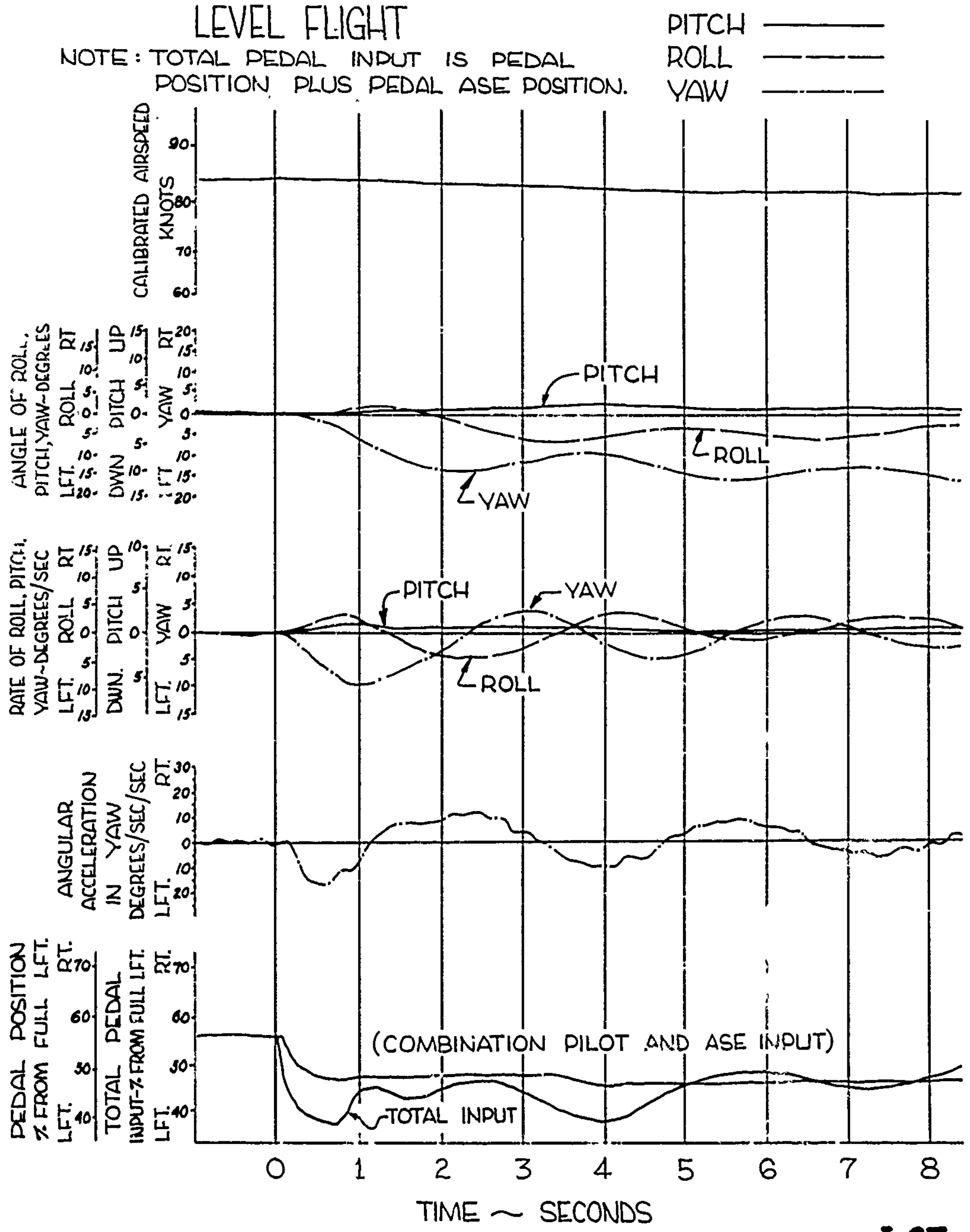


FIGURE NO. 67
RESPONSE TO A LFT. DIRECTIONAL HARD-OVER WITH RECOVERY
CH-37B, U.S.A., S/N 54-0998

FULL PEDAL TRAVEL = 3.8 INCHES
C.G. LOCATION = STATION 236.5 (MID)
AVG. GROSS WEIGHT = 25,780 LB.

TRIM CAS = 82 KNOTS
DENSITY ALTITUDE = 9410 FT.
RPM = 2605/186

LEVEL FLIGHT

NOTE: TOTAL PEDAL INPUT IS PEDAL POSITION PLUS PEDAL ASE POSITION.

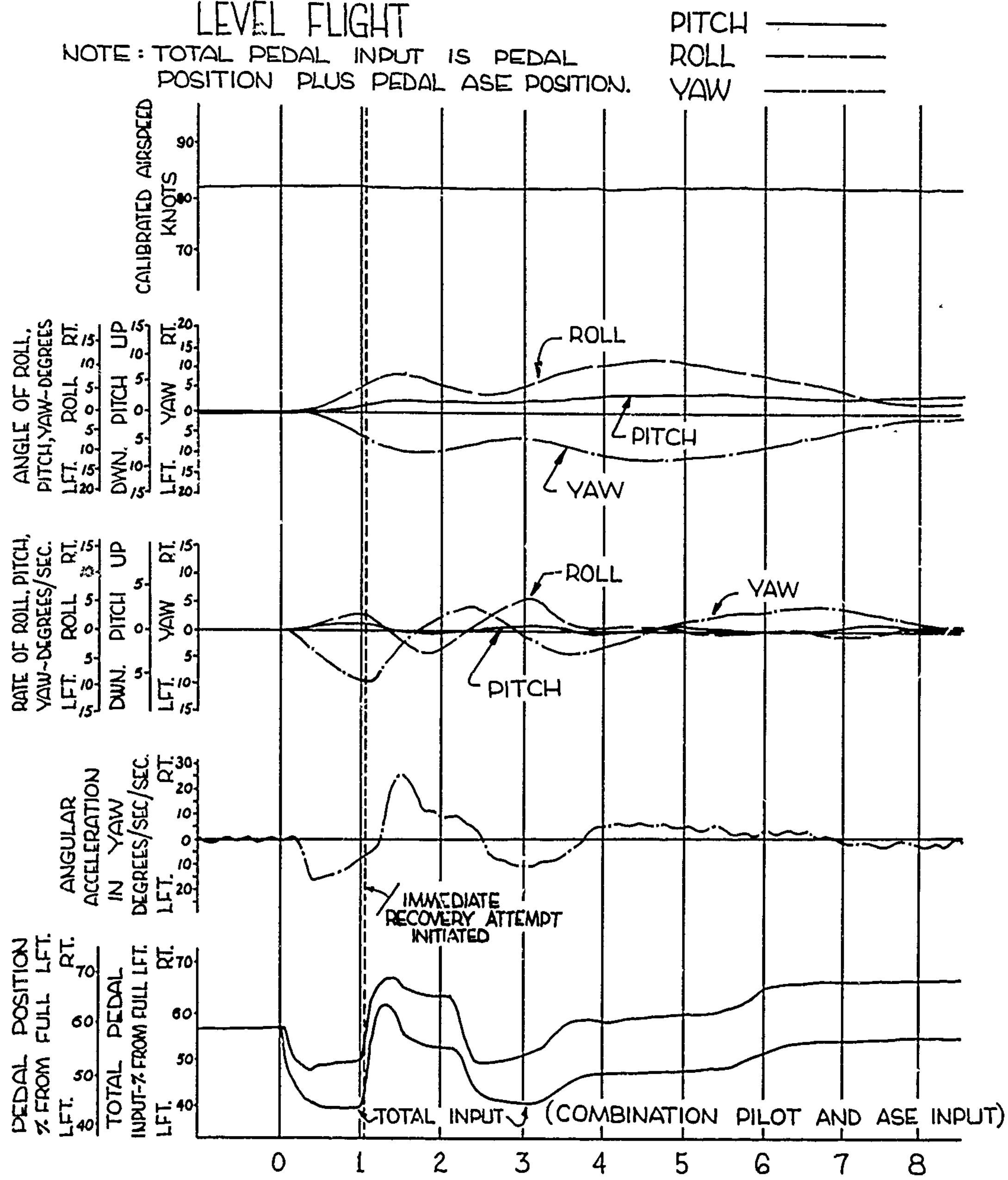


FIGURE NO. 68
RESPONSE TO A SIMULATED FAILURE IN THE ASE FEEDBACK CIRCUIT (OSCILLATING HARD-OVER), WITH RECOVERY~LONGITUDINAL
CH-37B, U.S.A., S/N 54-0998

FULL LONGITUDINAL TRAVEL = 16 INCHES
C.G. LOCATION = STATION 236.5 (MID)
AVG. GROSS WEIGHT = 25,730 LB.

TRIM CAS = 82 KNOTS
DENSITY ALTITUDE = 9910 FT.
RPM = 2605/186

LEVEL FLIGHT

NOTE: TOTAL LONGITUDINAL INPUT IS LONG STICK POSITION PLUS LONG. ASE POSITION.

PITCH ———
ROLL — — —
YAW —·—·—

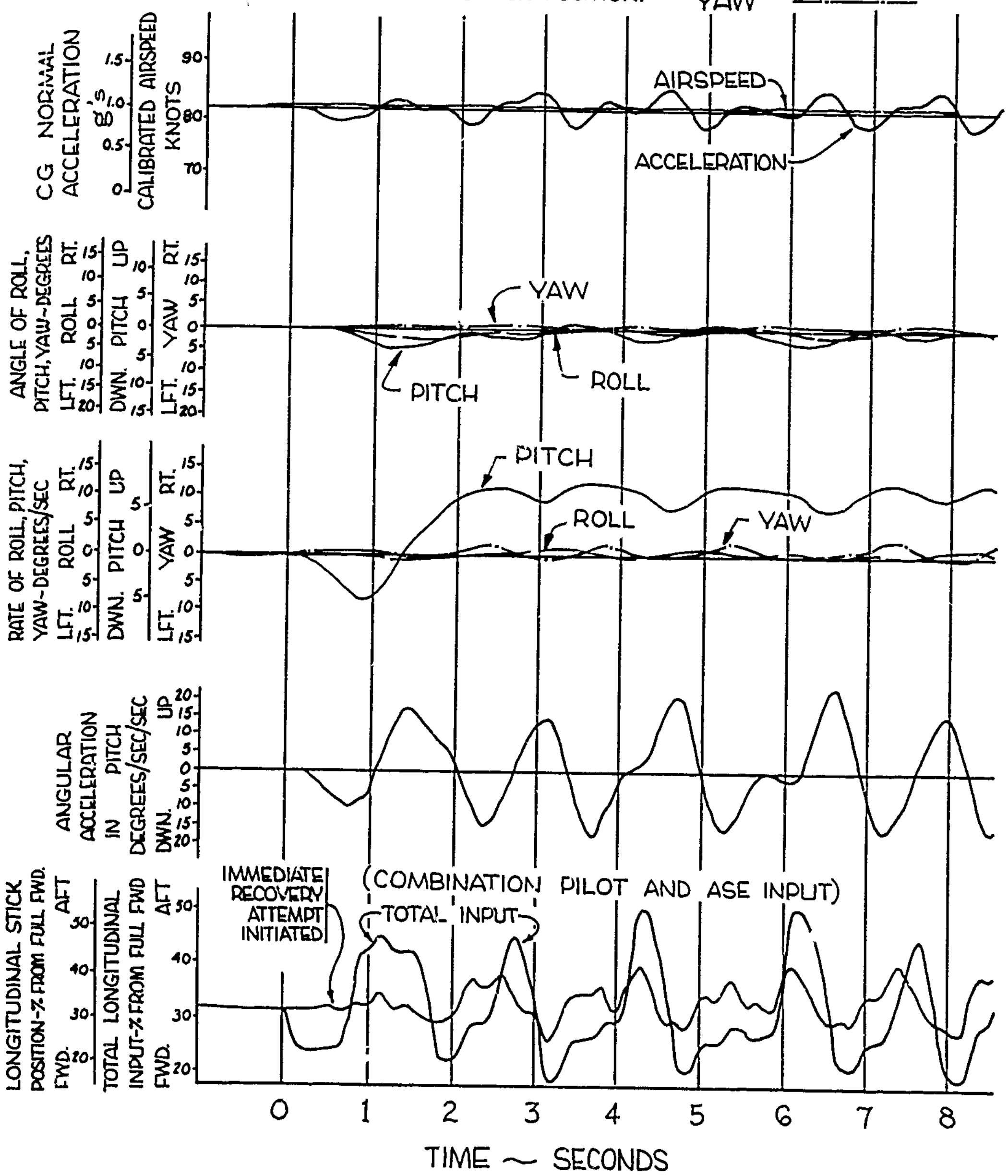


FIGURE NO. 69
RESPONSE TO A SIMULATED FAILURE IN THE ASE FEEDBACK CIRCUIT (OSCILLATING HARD-OVER), WITH RECOVERY ~ LATERAL
CH-37B, U.S.A., S/N 54-0998

FULL LATERAL TRAVEL = 15 INCHES
C.G. LOCATION = STATION 236.5 (MID)
AVG. GROSS WEIGHT = 25,650 LB.

TRIM CAS = 81 KNOTS
DENSITY ALTITUDE = 10,520 FT.
RPM = 2605/186

LEVEL FLIGHT

NOTE: TOTAL LATERAL INPUT IS LATERAL STICK POSITION PLUS LAT. ASE POSITION.

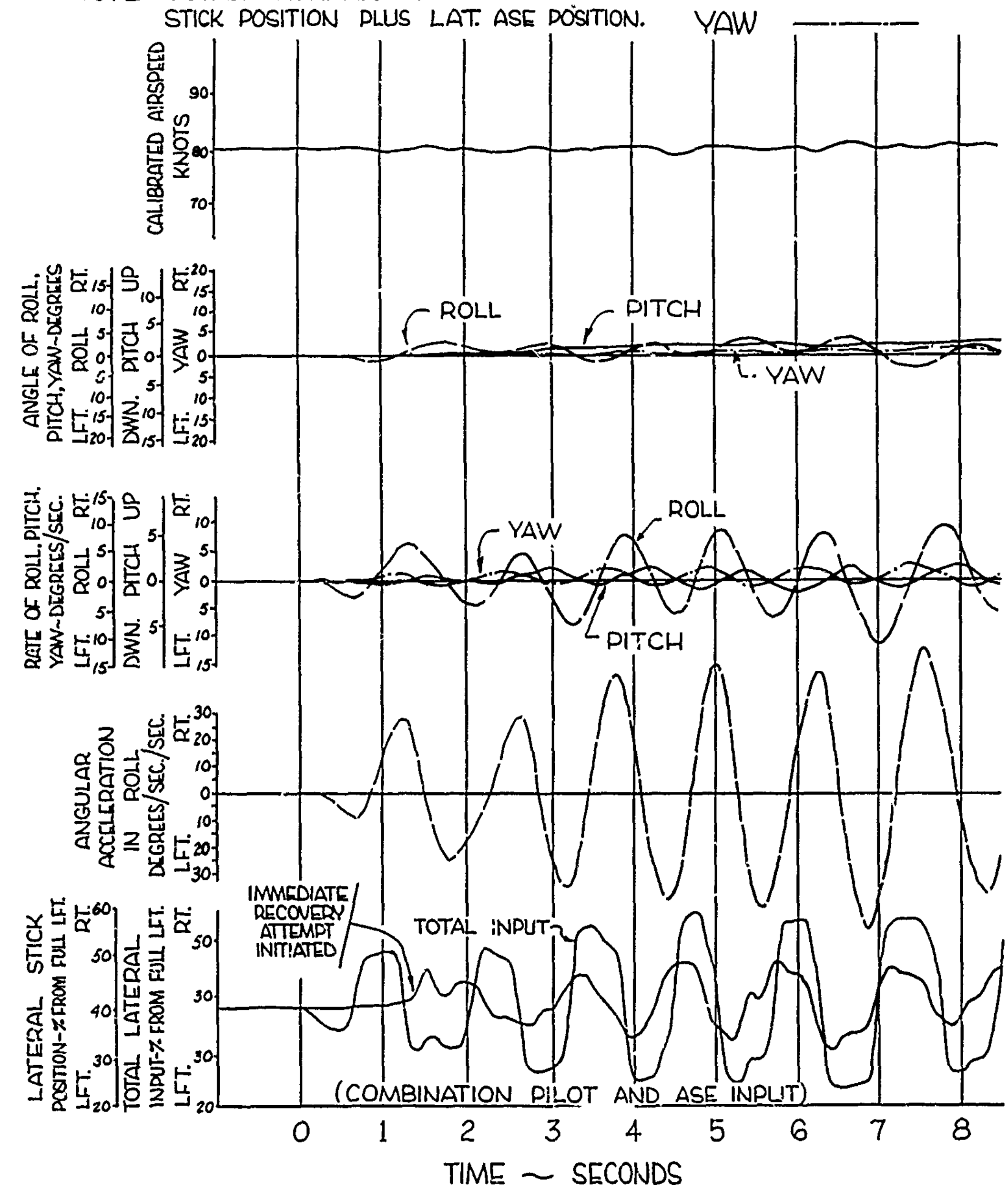


FIGURE NO. 70
RESPONSE TO A SIMULATED FAILURE IN THE ASE FEEDBACK CIRCUIT (OSCILLATING HARD-OVER), WITH RECOVERY ~ LATERAL
CH-37B, U.S.A., S/N 54-0998

FULL LATERAL TRAVEL = 15 INCHES
C.G. LOCATION = STATION 236.5 (MID)
AVG. GROSS WEIGHT = 25,160 LB.

TRIM CAS = 64 KNOTS
DENSITY ALTITUDE = 6320 FT.
RPM = 2662/190

CLIMB

NOTE: TOTAL LATERAL INPUT IS LATERAL STICK POSITION PLUS LAT. ASE POSITION.

PITCH ————
ROLL — — —
YAW —·—·—

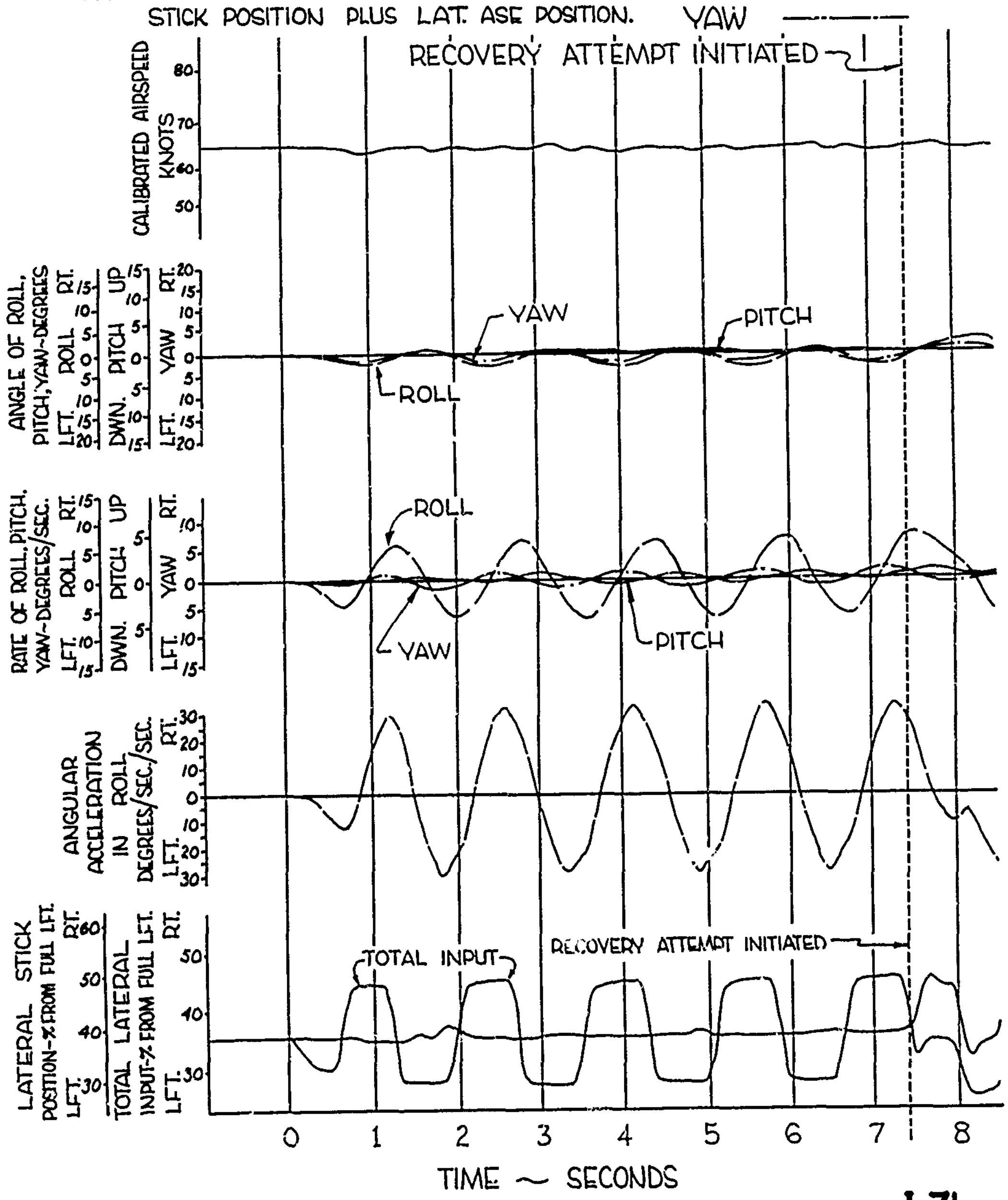


FIGURE NO. 70 (CONTINUED)

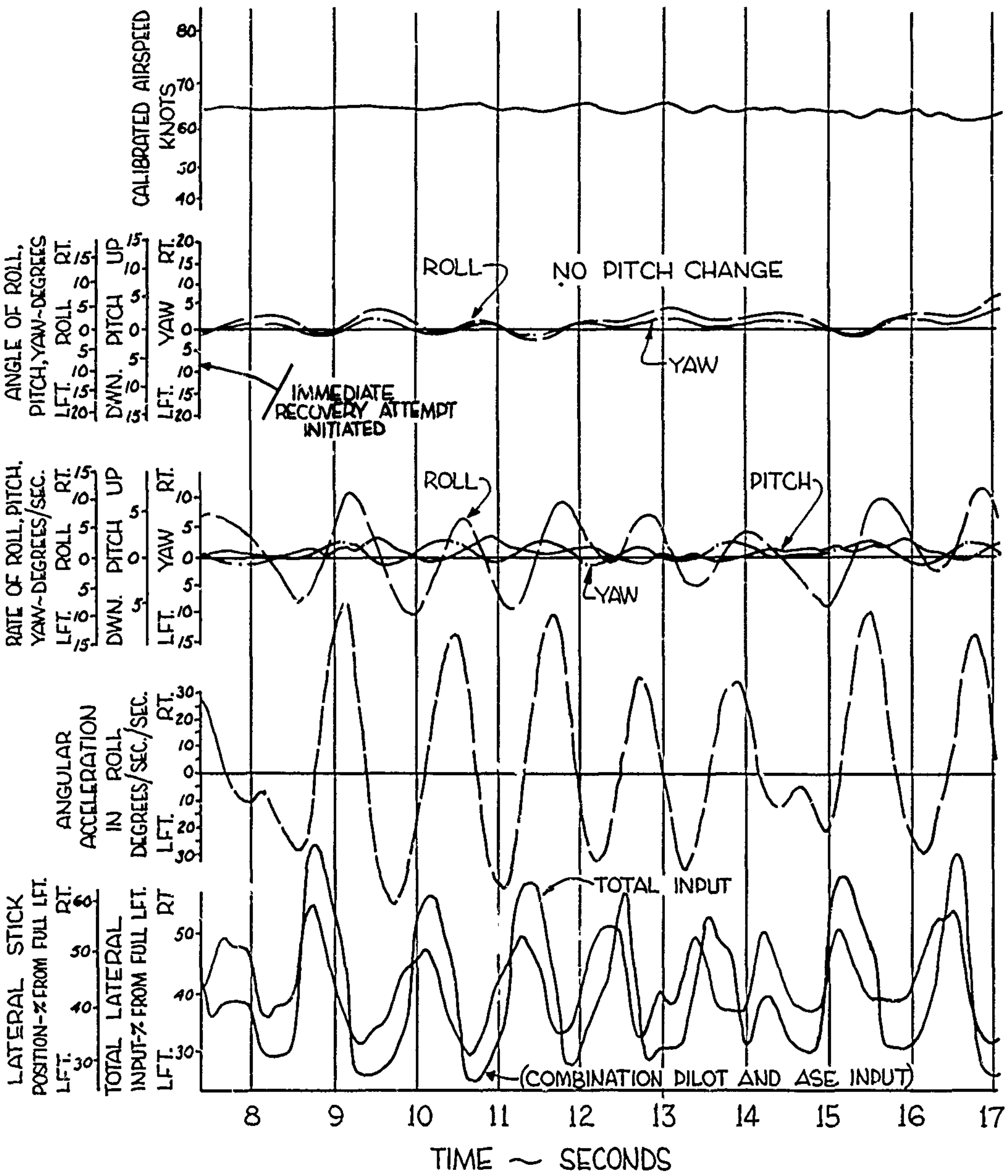


FIGURE NO. 71
RESPONSE TO A SIMULATED FAILURE IN THE ASE FEEDBACK CIRCUIT (OSCILLATING HARD-OVER), WITH RECOVERY~DIRECTIONAL
CH-37B, U.S.A. S/N 54-0998

FULL PEDAL TRAVEL = 3.8 INCHES
C.G. LOCATION = STATION 236.5 (MID)
AVG. GROSS WEIGHT = 25,610 LB.

TRIM CAS = 80 KNOTS
DENSITY ALTITUDE = 10,520 FT.
RPM = 2605/186

LEVEL FLIGHT

NOTE: TOTAL PEDAL INPUT IS PEDAL POSITION PLUS PEDAL ASE POSITION.

PITCH ————
ROLL — — —
YAW —·—·—

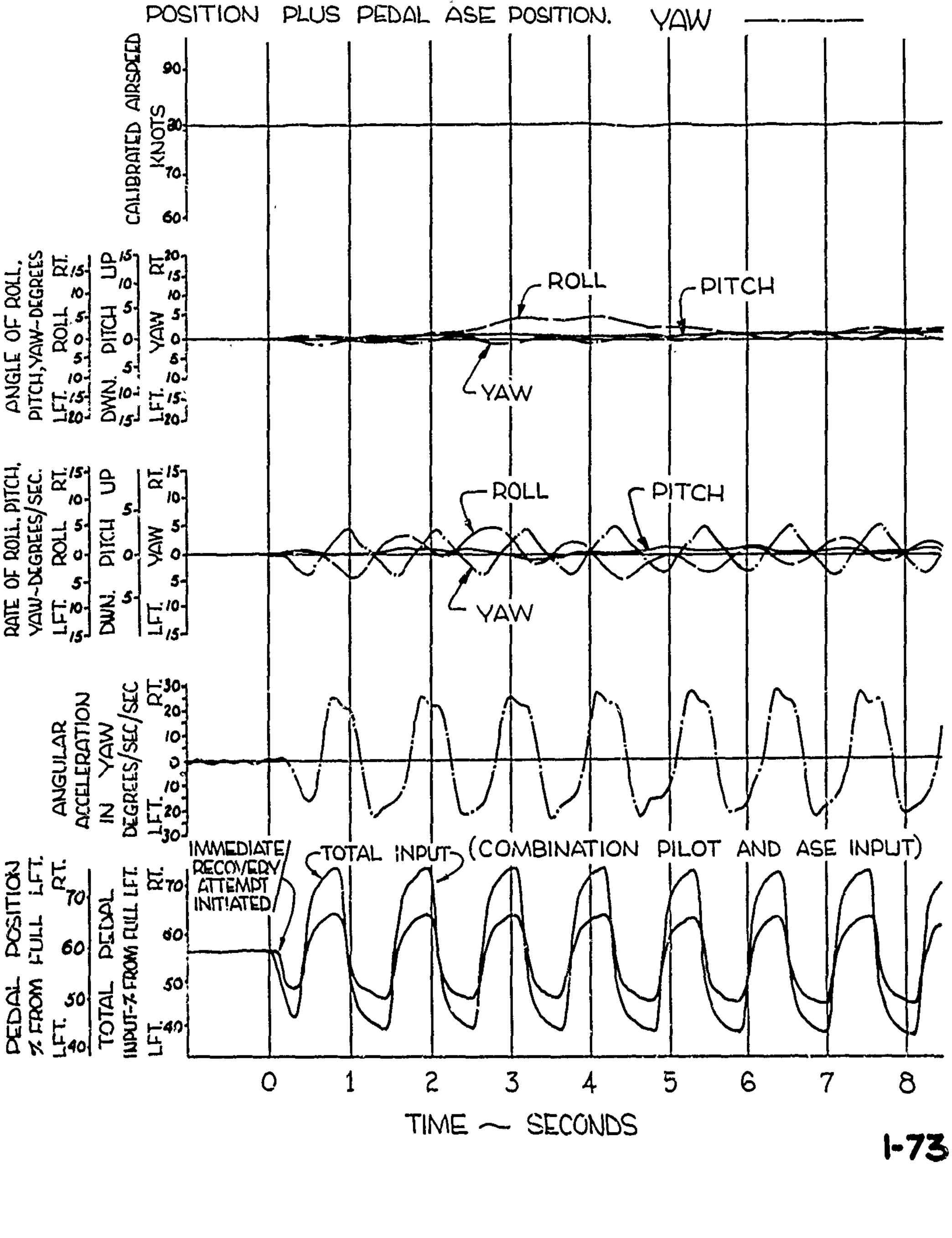


FIGURE NO. 72
RESPONSE TO A SIMULATED FAILURE IN THE ASE FEEDBACK CIRCUIT (OSCILLATING HARD-OVER), WITHOUT RECOVERY ~ DIRECTIONAL
CH-37B, U.S.A. S/N 54-0998

FULL PEDAL TRAVEL = 3.8 INCHES
C.G LOCATION = STATION 236.5 (MID)
AVG. GROSS WEIGHT = 25,400 LB.

TRIM CAS = 59 KNOTS
DENSITY ALTITUDE = 3250 FT.
RPM = 2690/192

AUTOROTATION

NOTE: TOTAL PEDAL INPUT IS PEDAL POSITION PLUS PEDAL ASE POSITION.

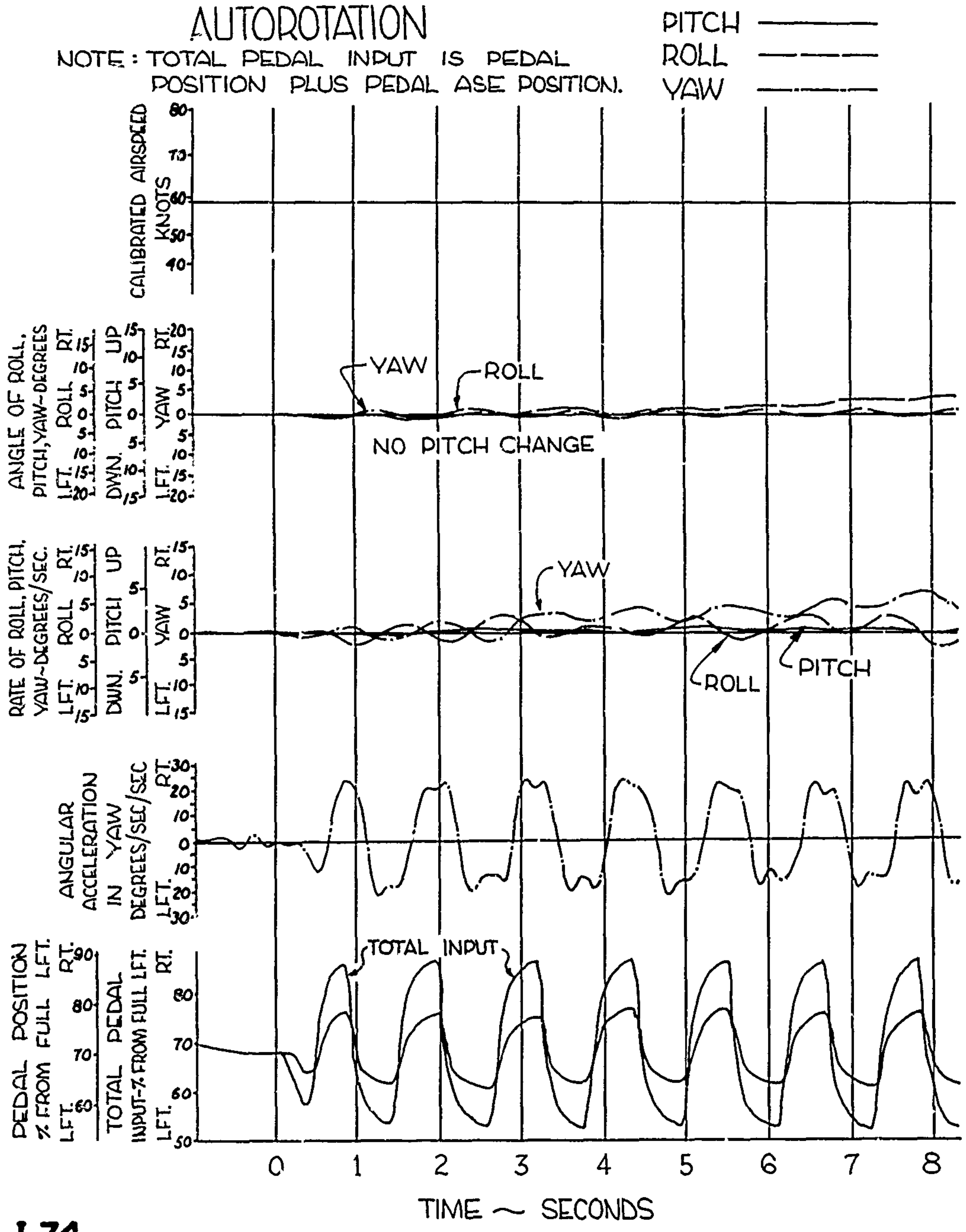


FIGURE NO. 73
RESPONSE TO A THREE-AXIS HARD-OVER
INDUCED BY ACTUATION OF TEST SWITCH
CH-37B, U.S.A., S/N 54-0998

FULL LONGITUDINAL TRAVEL = 16 IN.
FULL LATERAL TRAVEL = 15 IN.
FULL PEDAL TRAVEL = 3.8 IN.
C.G. LOCATION = STATION 239
AVG. GROSS WEIGHT = 25,300 LB.

TRIM CAS = 85 KNOTS
DENSITY ALTITUDE = 8300 FT.
RPM = 2605/186
PITCH ————
ROLL — — — —
YAW —·—·—

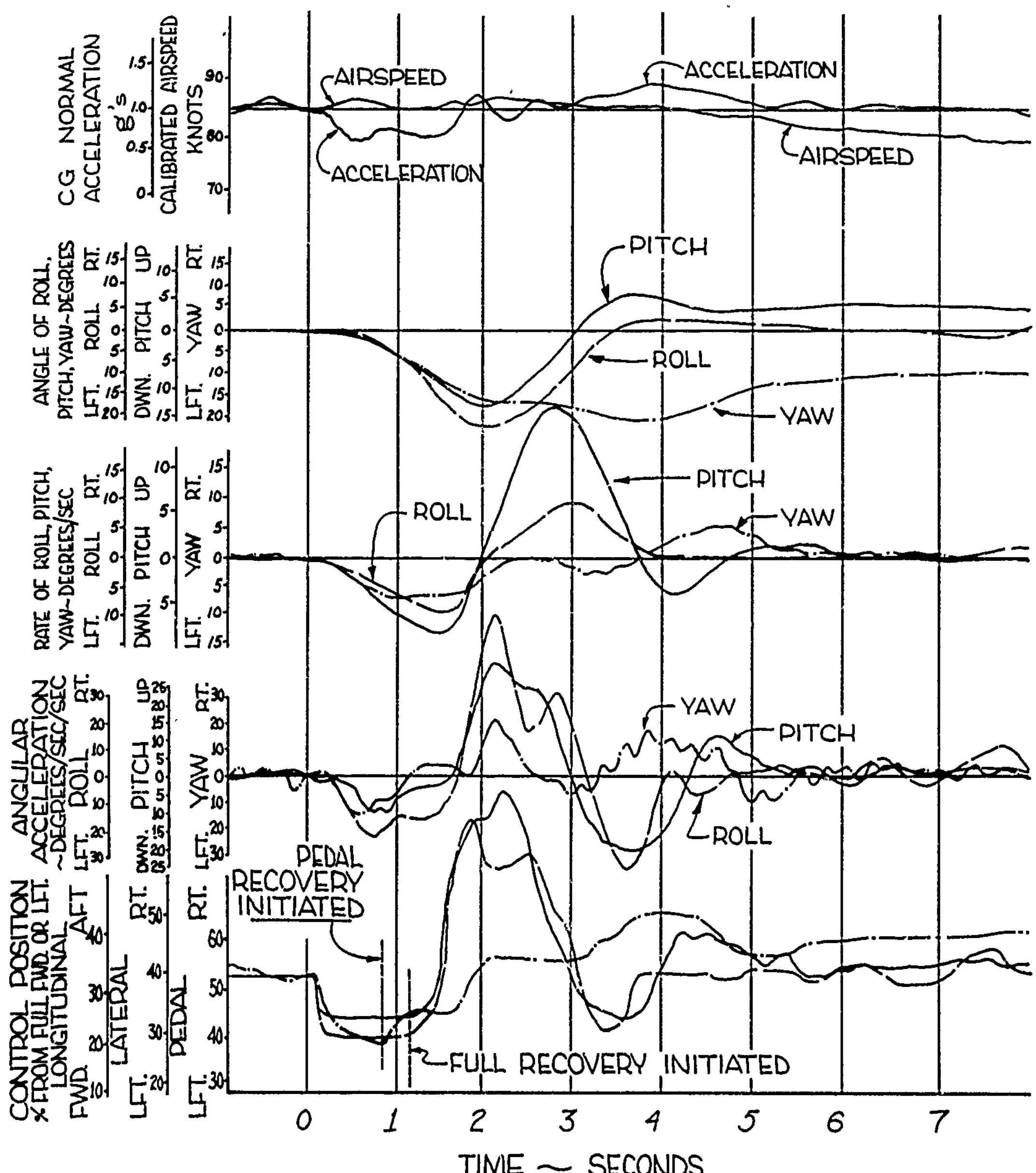


FIGURE NO. 74
PRESENTATION OF A VIBRATIONAL DISTURBANCE INDUCED BY AN ACTUAL ASE MALFUNCTION
CH-37B, U.S.A., S/N 54-998

C.G. LOCATION = STATION 242 (AFT)
AVG. GROSS WEIGHT = 30,360 LB.
CAS = 46 KNOTS
DENSITY ALTITUDE = 7010 FT.
RPM = 2605/186

NOTES: 1. OCCURRED 1.8 SECONDS AFTER FULL RECOVERY FROM A RIGHT LATERAL STEP.
2. TWO SIMILAR, LESS INTENSE DISTURBANCES OCCURRED IN THE SAME FLIGHT.
3. CAUSE IS UNDETERMINED.

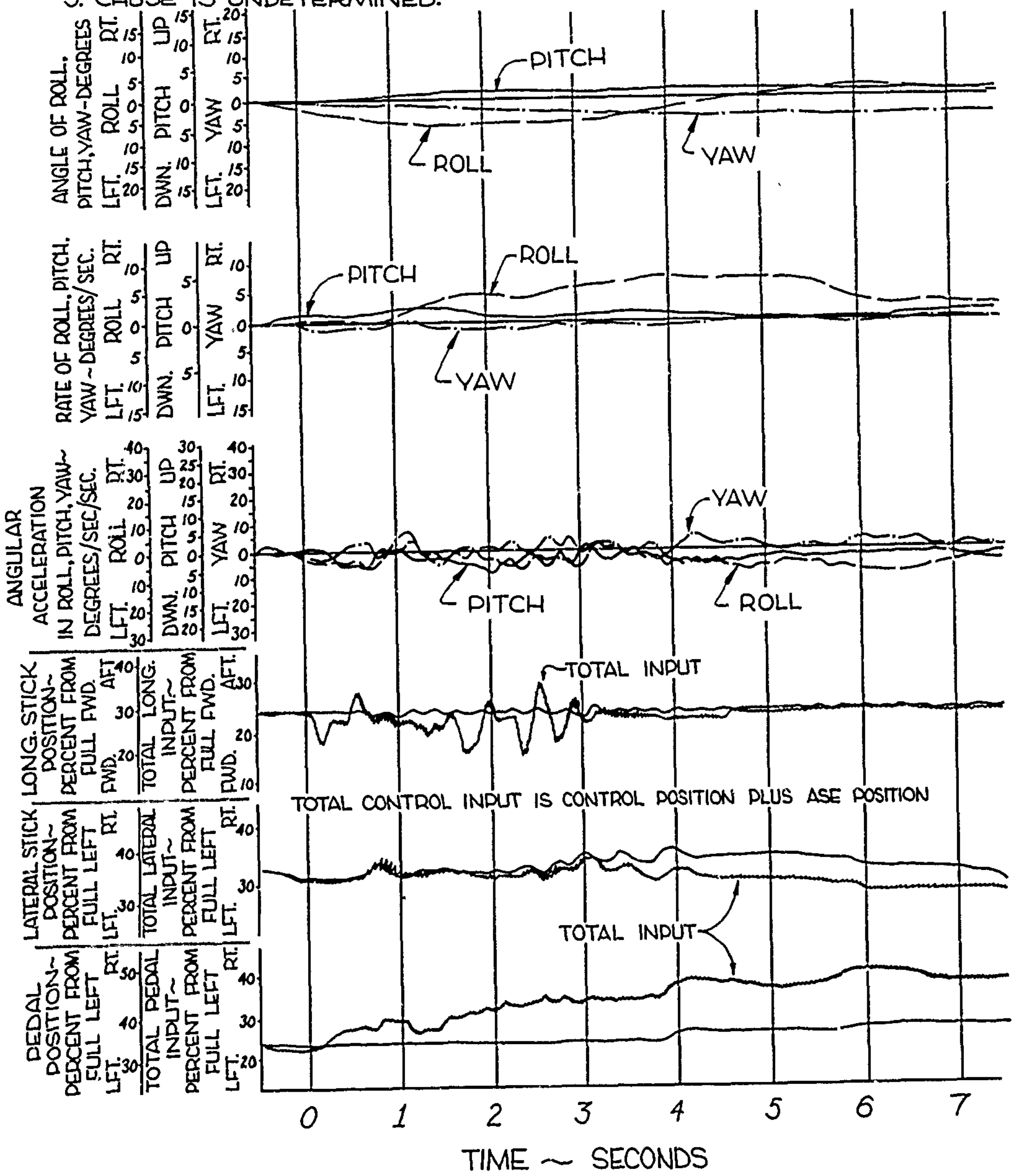


FIGURE NO. 75 (DELETED)

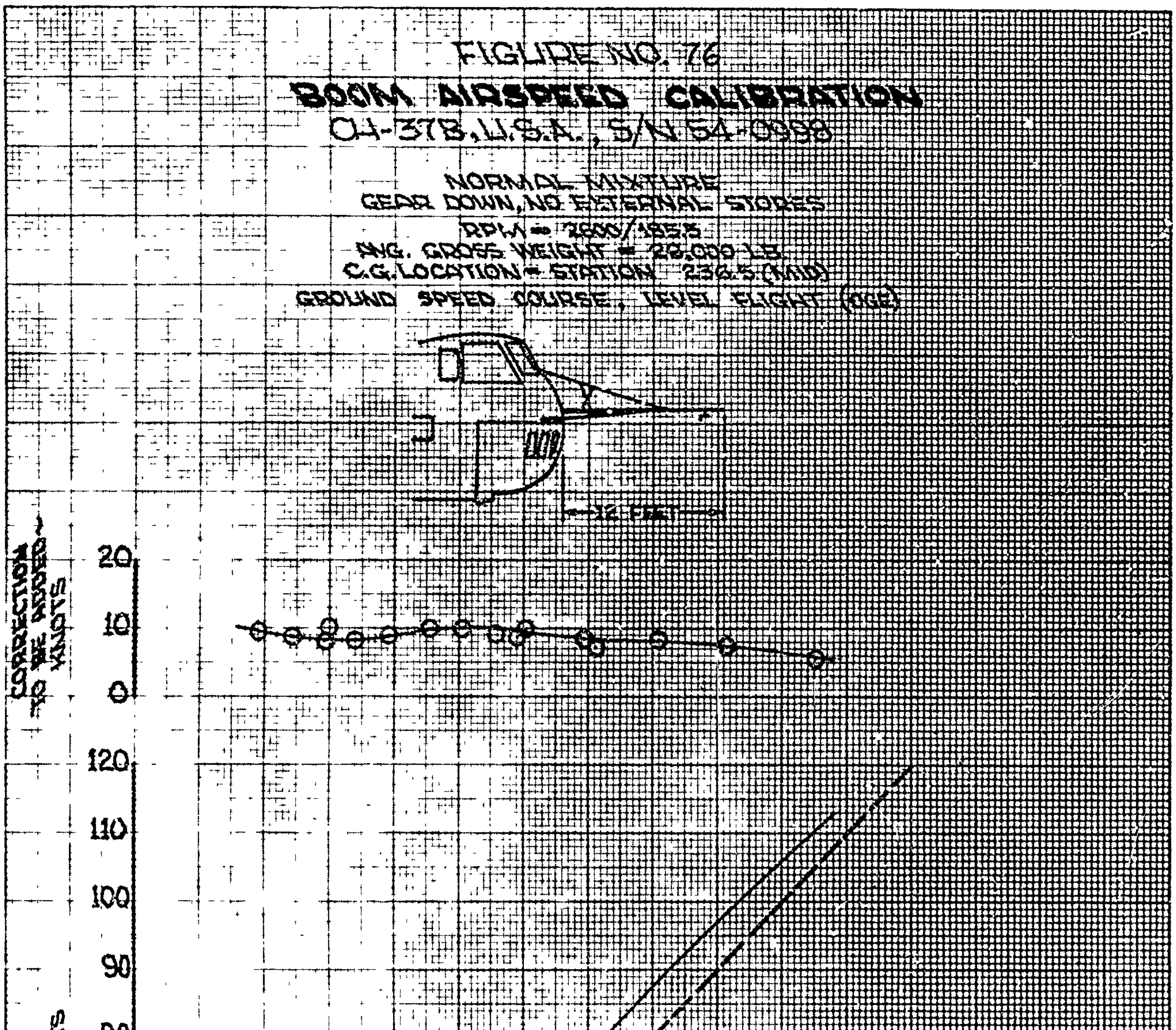


FIGURE NO. 76
BOOM AIRSPEED CALIBRATION
CH-37B, U.S.A., S/N 54-0998
NORMAL MIXTURE
GEAR DOWN, NO EXTERNAL STORES
RPM = 2600/1853
AVG. GROSS WEIGHT = 28,000 LB.
C.G. LOCATION = STATION 236.5 (MID)
GROUND SPEED COURSE, LEVEL FLIGHT (OGE)
12 FEET
CORRECTION TO BE ADDED ~ KNOTS
20
10
0
CALIBRATED AIRSPEED ~ KNOTS
120
110
100
90
80
70
60
50
40
30
20
10
0
0 10 20 30 40 50 60 70 80 90 100 110 120
INDICATED AIRSPEED ~ KNOTS

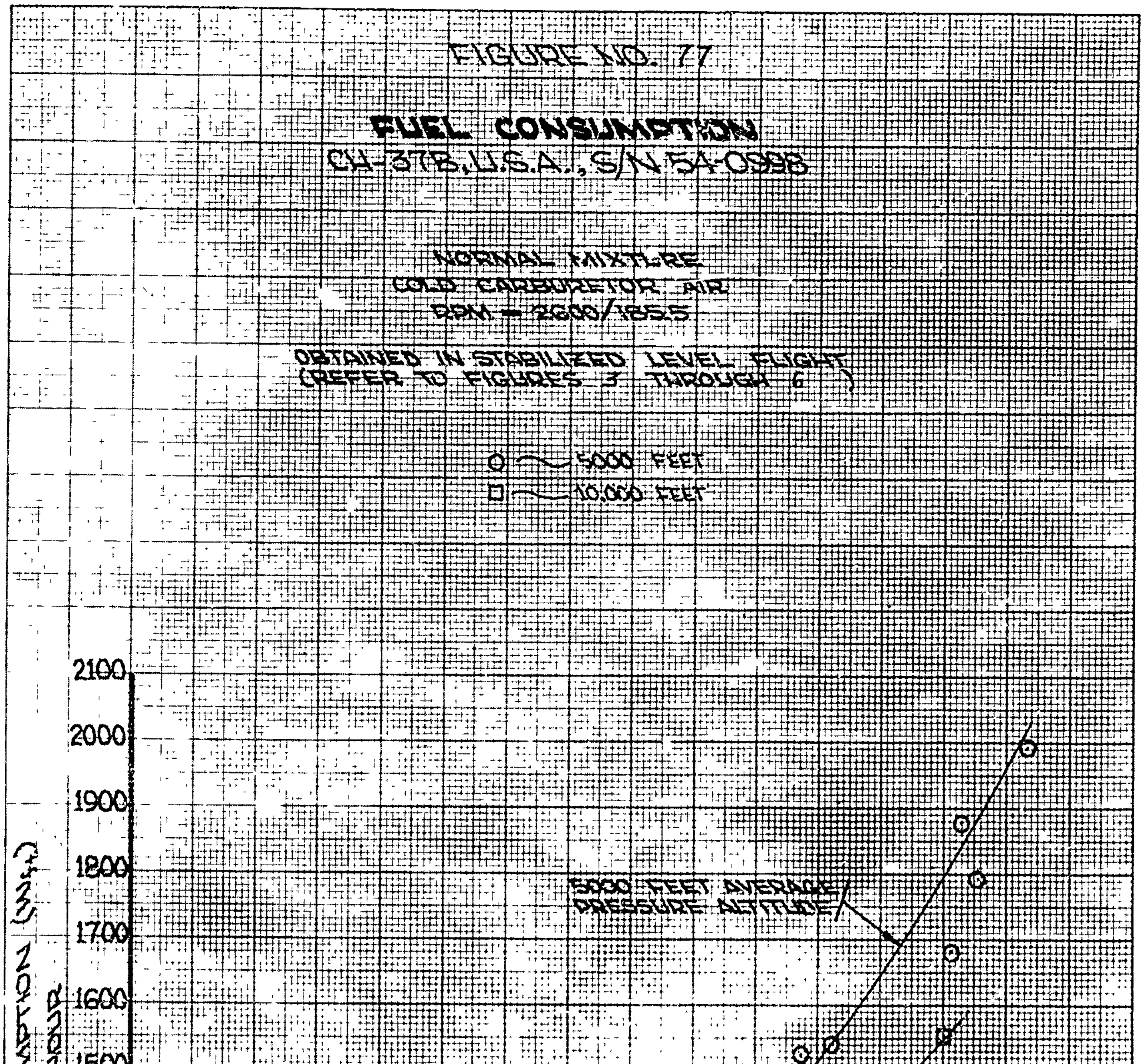
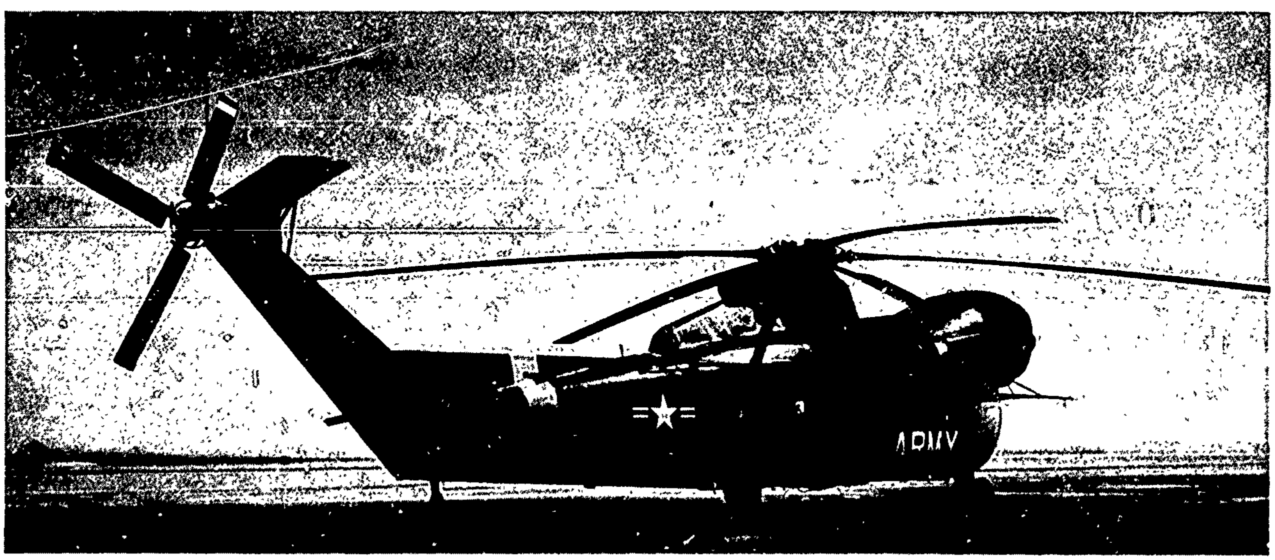


FIGURE NO. 77
FUEL CONSUMPTION
CH-37B, U.S.A., S/N 54-0998
NORMAL MIXTURE
COLD CARBURETOR AIR
RPM = 2600/1825
OBTAINED IN STABILIZED LEVEL FLIGHT
(REFER TO FIGURES 3 THROUGH 6)
5000 FEET
10,000 FEET
5000 FEET AVERAGE PRESSURE ALTITUDE
10,000 FEET AVERAGE PRESSURE ALTITUDE
TEST FUEL CONSUMPTION (Wf)
~ POUNDS PER HOUR
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
1400
1600
1800
2000
2200
2400
2600
2800
TOTAL ENGINE OUTPUT ~ TEST SHAFT HORSEPOWER

APPENDIX II



1.0 DESCRIPTION OF AIRCRAFT AND SYSTEMS

1.1 GENERAL

The CH-37B is a twin-engine, single-lifting rotor, all-metal cargo/transport helicopter. The CH-37B is a remanufacture of the CH-37A.

1.1.1 POWER

Power is provided by two Pratt and Whitney R2800-54, 18-cylinder, twin-row, reciprocating, radial engines, each equipped with a single-stage, single-speed supercharger. Each engine is rated at 2000 brake horsepower (BHP) maximum power (5-minute limit) and 1900 BHP normal rated power (maximum continuous). The engines are mounted in nacelles at the ends of short wings.

a. Carburetion

Each engine has a rectangular-barrel, pressure-type, down—draft carburetor equipped with an automatic mixture control. Two carburetor air levers, mounted on the engine control quadrant, mechanically actuate doors in the carburetor air intake duct by means of control cables and linkages. Mixture control is available in three stages: rich, normal, and idle cutoff. The fuel priming system is an integral part of the carburetor. Fuel is directed to discharge nozzles upstream of the impeller section of the engines for starting the engine.

b. Ignition

A low-tension-type ignition system is provided for each engine. Direct current flows from the circuit breaker to the starter relay, to the induction vibrators, then to the ignition switch. After the engine is started, the magneto supplies the power for firing the plugs.

c. Cooling

Air is forced over the engines by engine-driven fans. Cooling air is necessary as ram air is not available during hovering and ground operations.

d. Fuel System

A main and an auxiliary fuel system are provided for each engine. These systems are interconnected to permit use of all systems with one engine in case of an emergency. This also permits compensation for different rates of fuel comsumption between engines.

(1) Main Tanks

The two main tanks consist of two interconnected bladder-type fuel cells each, one located in the wing section and the other in the nacelle. An electrically operated sump-mounted booster pump in each wing cell supplies fuel under pressure to the system. Fuel flows from the tank through strainers and valves to the engine-driven fuel pumps and then to the carburetors.

(2) Auxiliary Fuel System

This system consists of either two external 150-gallon-or two 300-gallon-capacity drop tanks positioned approximately at cabin floor level and extending slightly forward of the wings. Auxiliary tanks were not used during this evaluation.

1.1.2 TRANSMISSION

a. Engine Drive Shafts

These shafts slant inboard and forward at approximately 10 degrees and each is splined to a hydromechanical rotor clutch.

b. Clutches

The clutches are connected to the main gear box.

c. Main Gear Box

This unit, containing a two-stage planetary gear system, reduces engine rpm at a ratio of 14.01:1.

d. Tail Rotor Drive Shaft

Extending aft from the main gear box, this shaft drives the intermediate gear box.

e. Rotor Brake

The rotor brake is located on the tail-rotor drive shaft just aft of the main gear box.

f. Intermediate Gear Box

Located at the base of the tail-rotor pylon, this gear box changes the direction of the torque transmission to the tail rotor and provides a disconnect point for folding the tail-rotor pylon.

g. Tail Gear Box

The tail gear box located at the top of the pylon contains a right-angle bevel gear reduction drive system to transmit engine torque to the tail rotor.

1.1.3 ROTOR SYSTEM

This system consists of the main rotor system and the tail rotor system which are driven through the transmission system and controlled by the flight control system.

1.1.3.1 Main Rotor System

The main rotor head and the five main rotor blades make up the main rotor system.

a. Main Rotor Head

The main rotor head supports the five main rotor blades and provides means for transmitting the movements of the flight controls to the blades. The following items comprise the main rotor head: the main rotor hub, which consists of an upper and lower plate, hinge assemblies, sleeve-spindle assemblies, and five dampers; the star assembly, which consists of a rotating star and a stationary star; restrainers; rods and assemblies; scissors; and locks.

b. Main Rotor Blades

Th- five all-metal main rotor blades are constructed of aluminum al]. xcept for steel cuffs at the root ends. The chord is 23.65 inches. The blade hinging is fully articulated. Restrainers and stops limit the motions. The leading edge of each blade is a hollow extruded spar; the trailing edge consists of individual pockets of honeycomb ribbed core construction bonded to the leading edge spar.

1.1.3.2 Tail Rotor System

Four all-metal blades, a rotor assembly, and a pitch-change mechanism make up the tail rotor system. The blades are fully articulated. The tail-rotor drive shaft is hollow to facilitate the blade pitch changing mechanism.

1.1.4 FLIGHT CONTROL SYSTEM

This system consists of a main control system, the cyclic-stick trim system, the tail-rotor flight control system, the flight control servo hydraulic system, and the automatic stabilization equipment (ASE).

a. Main-Rotor Flight Control System

This system provides longitudinal, lateral and vertical control by mechanical and hydraulic means. The cyclic stick changes the pitch of the main rotor blades to create lift as they rotate, thus effectively tilting the tip path plane and providing horizontal as well as vertical thrust. Hydraulically operated flight control servos assist the mechanical linkage.

b. Cyclic Trim System

The cyclic trim system permits trimming of the cyclic stick by means of the two spring-loaded struts connected to magnetic brakes.

c. Tail-Rotor Flight Control System

This control system compensates for main rotor torque and permits directional control. Control action is assisted by hydraulically operated flight control servos. Dampers prevent abrupt movements.

d. Flight Control Servo Hydraulic System

The servo hydraulic system eliminates high stick forces and, because of nonreversibility, reduces the main-rotor vibratory loads.

e. Automatic Stabilization Equipment (ASE)

See Paragraph 1.2.1 for description.

1.2 MAJOR DIFFERENCES BETWEEN THE CH-37B AND THE CH-37A

Listed below are the items incorporated during remanufacture that had an effect on the performance, stability, or control of the CH-37B. These items are either changes or additions, as noted, to the CH-37A.

1.2.1 AUTOMATIC STABILIZATION EQUIPMENT (ASE) (ADDITION)

The purpose of the ASE is to improve the handling characteristics of the helicopter to permit automatic cruising flight and hands-off hovering. The ASE provides improved dynamic stability within the C.G. limitations of the helicopter. The ASE incorporates four control channels: pitch, roll, yaw, and altitude. In each channel an appropriate electrical displacement signal is initiated, modified, and amplified to provide a control voltage for the servo motor assembly. The servo motor assembly actuates the helicopter's flight control system in such a manner as to dampen the helicopter's motion. The control action of the ASE is limited to approximately 25 percent of the range of the helicopter flight control system authority. An ASE block diagram is presented in Figure F, (See next page).

1.2.2 FIXED STABILIZER (CHANGE)

The adjustable stabilizer located on each side of the aft fuselage section of the CH-37A was removed and a fixed stabilizer was attached to the CH-37B on the top right-hand side of the pylon opposite the tail rotor. The fixed stabilizer was installed with a 10-degree dihedral angle and a zero-degree incidence setting.

1.2.3 CARGO DOOR (CHANGE)

The CH-37B has a sliding cargo door located in the aft section of the cabin on the right-hand side of the fuselage. The door consists of forward and aft sections that ride on tracks above and below the door. This improved door replaces the three-section CH-37A door.

1.2.4 OIL TANK (CHANGE)

A rigid fiberglass oil tank with a normal capacity of 30 gallons replaces the bladder-type oil tank of 13.3 gallons normal capacity that was incorporated in the CH-37A.

1.3 AIRCRAFT DIMENSIONS AND DESIGN DATA

a. General

(1) Main rotor disc diameter	72 ft
(2) Tail rotor disc diameter	15 ft
(3) Width (overall)	
(a) Maximum (with rotors stationary)	(approx) 68 ft 5.75 in
(b) Minimum (with rotors stationary)	(approx) 65 ft 1.5 in
(c) Minimum (with main rotor blades folded or removed	27 ft 4.0 in
(d) Width (at tail cone)	17 ft 10 in
(4) Length (overall)	
(a) Maximum (both rotors at extreme position)	88 ft
(b) Minimum	
1. (Both rotors at minimum positions)	79 ft 6.64 in
2. (Main rotor at minimum; tail rotor at extreme	(approx) 81 ft 4.35 in
3. (Main rotor at extreme; tail rotor at minimum)	(approx) 85 ft 11.61 in
(c) Minimum (blades and pylon folded)	55 ft 8.0 in
(5) Height (overall)	
(a) Maximum (tail rotor at high position)	22 ft

(b)	Minimum (tail rotor at low position)	20 ft 0.23 in
(c)	Height (pylon folded at tail cone)(rotor at 35.75 degrees)	15 ft 1 in

b. Rotors

(1) Main Rotor Blades

(a)	Number of blades	5
(b)	Weight (approx per blade)	350 lb
(c)	Airfoil section (curve identification)	NACA 0010.9
(d)	Total blade area (five blades)	287.5 sq ft
(e)	Area per blade	57.5 sq ft
(f)	Area of rotation (rotor disc area)	4071.5 sq ft
(g)	Blade radius	36 ft
(h)	Chord at root	23.65 in
(i)	Chord at tip	23.65 in
(j)	Disc loading (at normal gross weight)	(approx) 7.228 lb/sq ft
(k)	Rotary solidarity ratio (effective)	0.0865
(l)	Angle of incidence in neutral (all blades)	10 deg 33 min at root 6 deg 48 min at 75% chord
(m)	Ground clearance (rotating) Minimum	(approx) 14 ft 4 in
(n)	Ground clearance (static)	(approx) 12 ft

(2) Tail rotor blades

(a)	Number of blades	4
(b)	Airfoil section	NACA 0012 (modified)
(c)	Tail blade area (4 blades)	31.35 sq ft
(d)	Area per blade	7.8375 sq ft
(e)	Area of rotation (rotor disc area)	176.71 sq ft
(f)	Blade radius	7 ft 6 in
(g)	Chord at root	13.5 in
(h)	Chord at tip	13.5 in
(i)	Rotor solidarity ratio (total blade area divided by disc area)	0.1774

(j) Ground clearance (rotating) — 7 ft 0.23 in

(k) Ground clearance (static) — 7 ft 0.23 in

c. Wing

(1) Total area, including: — 250.6 sq ft

(a) Fuselage — 51.2 sq ft
(b) Nacelles (both) — 187.2 sq ft

(2) Chord at root (aircraft centerline) — 5 ft 8 in

(3) Chord at tip (theoretical extended section) — 5 ft 8 in

d. Horizontal stabilizer (fixed)

(1) Area	24.5 sq ft
(2) Span	6 ft 5 in
(3) Chord at root	46.44 in
(4) Chord at tip	46.44 in
(5) Dihedral	10 deg
(6) Airfoil at root	NACA 14 0.0015 (MOD.)
(7) Airfoil at tip	NACA 16 0.0009 (MOD.)
(8) Angle of incidence	0 deg

e. Fuselage (without main and tail rotor blades)

(1) Maximum width (to outside of nacelles)	27 ft 4 in
(2) Maximum length	64 ft 10.69 in
(3) Height - Maximum(without landing gear)	15 ft 2.78 in
Maximum(with landing gear)	17 ft 2 in
(4) Height of door level above ground (static)	2 ft 11.4 in
(5) Door dimensions (cargo)	
(a) Width	5 ft 9.8 in
(b) Height	6 ft
(6) Total cubic feet of cargo space	1252.7 cu ft

1.4 TEST INSTRUMENTATION

Sensitive instrumentation to measure the following parameters was supplied, installed, and maintained by the Instrumentation Branch of the Logistics Division, USAATA. All of the instrumentation listed was calibrated by AFFTC with the exception of the items marked with an asterisk (*), which were calibrated by USAATA.

a. Pilot's Panel

1. Airspeed (Boom)
2. Altitude (Boom)
3. Airspeed (Std)
*4. Free Air Temperature
5. Rate of Climb (Boom)
*6. Angle of Sideslip
7. Engine Speed (left and right engine)
8. Manifold Pressure (left and right engine)
*9. Carburetor Air Temperature (left and right engine)
10. Main Rotor Speed
11. Torque (left and right engine)
12. Total fuel Used (left and right engine)
13. Fuel Flow (left and right engine)

b. Oscillograph

*1. Longitudinal Control Position
*2. Lateral Control Position
*3. Pedal Position
*4. Collective Pitch Position
*5. Angle of Attack
*6. Angle of Sideslip
7. Angle of Pitch
8. Angle of Roll
9. Angle of Yaw
10. Rate of Pitch
11. Rate of Roll
12. Rate of Yaw
13. Angular Acceleration in Pitch
14. Angular Acceleration in Roll
15. Angular Acceleration in Yaw
16. Normal Acceleration at the C.G.
*17. Boom Airspeed
18. Boom Altitude
19. Rotor RPM (linear)
*20. Total Longitudinal Control Input[1]

[1]Total input is control position plus the respective ASE position.

*21. Total Lateral Control Input[1]
*22. Total Directional Control Input[1]

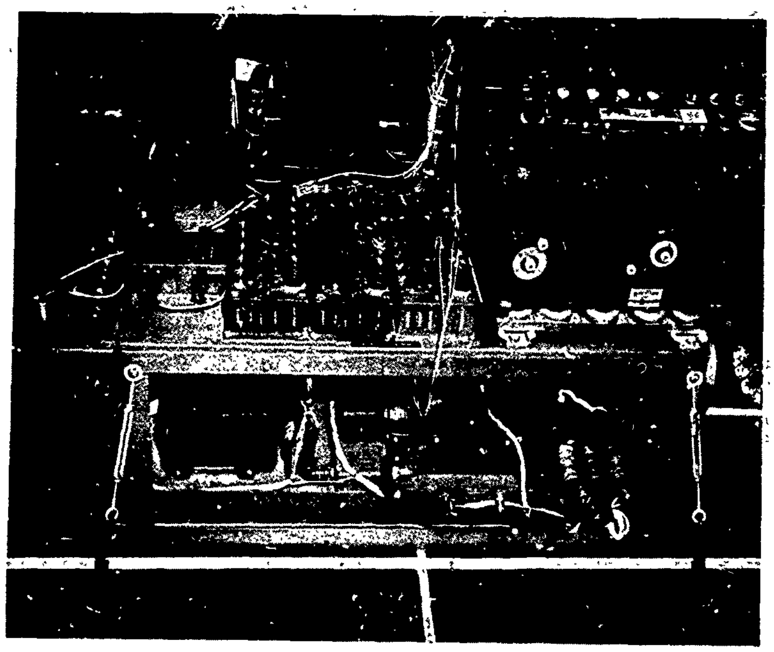


PHOTO 1 - OSCILLOGRAPH INSTRUMENTATION PACKAGE

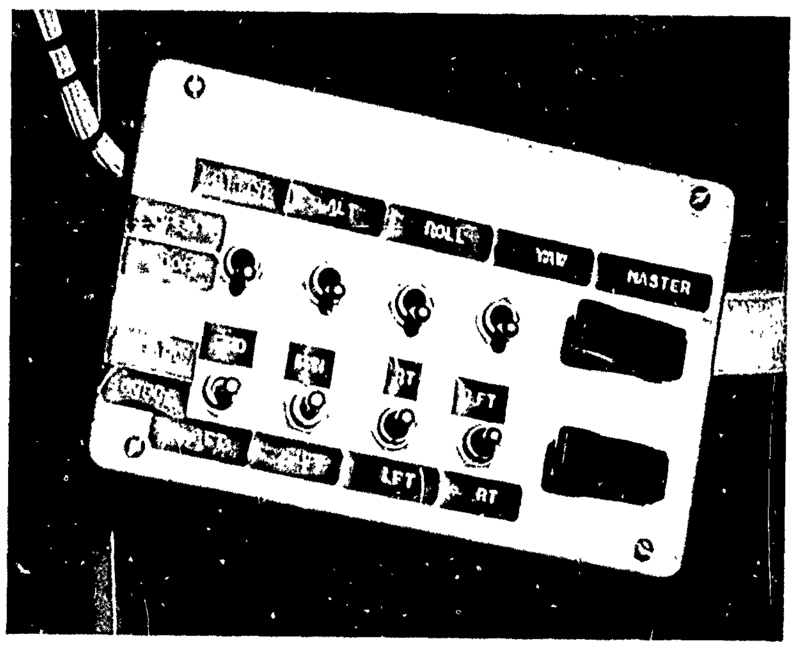


PHOTO 2 - HARDOVER CONTROL BOX

[1]Total input is control position plus the respective ASE position.

1.5 WEIGHT AND BALANCE

The following loadings were used during the performance and stability and control evaluation of the CH-37B:

a. 26,500 lb Mid C.G.

Basic Weight (Full Oil, 50 Gal)	23,259 lb
Crew (4)	800
Fuel	2,100
Ballast	541
	26,700 lb

b. 28,500 lb Mid C.G.

Basic Weight (Full Oil, 50 Gal)	23,259 lb
Crew (4)	800
Fuel	2,351
Ballast	2,090
	28,500 lb

c. 30,500 lb Mid C.G.

Basic Weight (Full Oil, 50 Gal)	23,259 lb
Crew (4)	800
Fuel	2,351
Ballast	4,090
	30,500 lb

d. 31,500 lb Mid C.G. and Aft C.G.

Basic Weight (Full Oil, 50 Gal)	23,259 lb
Crew (4)	800
Fuel	2,351
Ballast	5,090
	31,500 lb

In all cases the ballast was distributed in the cargo area to provide the desired C.G. location.

APPENDIX III

Symbols and Abbreviations

SYMBOL	DEFINITION	UNITS
C_P	Power Coefficient	Non-dimensional
C_T	Thrust Coefficient	Non-dimensional
μ	Rotor Tip Speed Ratio	Non-dimensional
BHP	Brake Horsepower	ft-lb/min
ρ	Air Density	Slugs/ft^3
A	Rotor Disc Area	Sq ft
Ω	Angular Velocity	Radians/sec
R	Rotor Radius	ft
W	Aircraft Gross Weight	lb
V_t	True Airspeed	kt
KCAS	Knots Calibrated Airspeed	kt
KTAS	Knots True Airspeed	kt
rpm	Revolution per Minute	rpm
C.G.	Center of Gravity	-
H_D	Density Altitude	ft
σ	Density Ratio	-